Engineering Library

APR 4 - 1932

Engineering News-Record

Twenty-five cents, five dollars per year McGraw-Hill Publishing Company, Inc.

March 31, 1932

Using City Revenue Efficiently

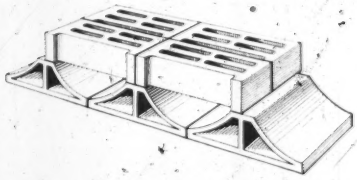
By C. A. Dykstra
City Manager, Cincinnati, Ohio

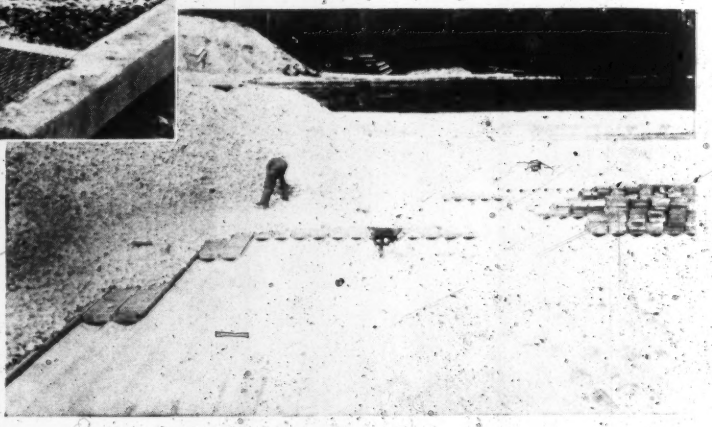
Also:

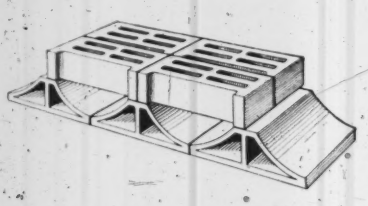
Welded Viaduct on H-Section Piles
A Waterless Dry-Seal Gasholder
Dredge Fill for Chicago Park
Levee Building With Tower Excavator
Subway Contracts and Specifications

ing sand through trestle-supported pipe-lines to spillway and gates in Lake Pontchartrain

Designed to Meet Exacting Requirements . . . .







"SOUND *filter media . . . uniform dosage . . . sufficient aeration . . . and proper underdrainage.*"

The requirements of a *successful* trickling filter system are so exacting that they can be met only in proportion to the efficiency of the filter tile specified. Media and dosage of course demand reasonable attention . . . Aeration and underdrainage are, however, matters of design that are built into the very structure of the filter floor.

Metro Filter Flooring was designed to meet exacting requirements. Sufficient aeration is guaranteed by the ratio of free openings (43%) in the Metro Grill Block. Proper underdrainage is assured by the Metro Channel Block. Sufficient strength is provided to support the filter media.

This type of construction not only permits uninterrupted operation but facilitates inspection . . It eliminates the heavy expense ordinarily incurred for supervision and maintenance. . . Economy is another word for it.

(Miniatures of the Metro Channel and Grill Blocks will be sent on request.)

THE METROPOLITAN PAVING BRICK CO.
CANTON, OHIO

Manufacturers of Metro Canton, Bessemer, Ohican, and Cleveland Paving Block • Architectural Face Brick • Structural Clay Tile • Metro Trickling Filter Flooring •

Metropolitan
TRICKLING FILTER FLOORING

Tune in on the Good Roads Program . . . Saturday evenings at 8 p. m. over WTAM (Cleveland)

Engineering News-Record

Established 1874 ✦ A Weekly Journal of Civil Engineering and Construction Practice ✦ McGraw-Hill Publishing Company, Inc.

F. E. Schmitt, Editor

Volume 108 | New York, March 31, 1932 | Number 13

First Aid to Employment

THE most important event in a hectic week of important happenings is the loan just made by the Reconstruction Finance Corp. to the New York Central R.R. for continuing construction on its West Side Improvement in New York. Though four millions is not a great deal of money, the loan is of vast significance because it is the first direct aid to employment-making construction that has resulted from the government's heroic measures to rehabilitate credit. All prior aid from this source, to banks as well as to railroads, was given for the purpose of clearing up debts, and so did no more than remove a debit from one corporation's books and place a corresponding credit on another corporation's books. Such bookkeeping shifts, however vital in their effect on solvency and financial confidence, do not put many idle men to work. Since construction is the direct creator of employment, this first instance of promotion of construction wakens the hope that further aid of the same kind will soon be extended.

Leading Articles

Using City Revenue Efficiently 458
Concrete Resurfacing on Sand 461
Welded Overcrossing on Steel Piles . . 463
Dry-Seal Waterless Gasholder 466
Pumping Sand for Chicago Park 468
Subway Contracts and Specifications . 471
Tower Excavators for Levee Building . 474
Locating Slab Steel 477
Lateral Clay Pressure Phenomena . . 479
Replacing Old Thames River Bridge . 480

Uncertain Future

DESPITE this promise that important railroad construction operations can be continued the general outlook for the railroads is full of uncertainty. Net operating income of the principal railroads for January and February, with few exceptions, shows a falling off from last year. Probably the gains due to the increases in freight rates authorized late last year do not show up in these figures, as they are being segregated and turned over to the Railway Credit Corp. to aid roads which need help in meeting bond interest and maturing obligations. How much money is being turned over to that corporation or to what extent it will prove adequate in meeting urgent needs is not yet known, nor is it known whether the additional help obtainable from the Reconstruction Finance Corp. will prove adequate if railroad traffic continues to decline. Refusal of banking houses long and profitably associated with the financial operations of the Missouri Pacific Ry. to renew more than half of a loan to the railroad appears to reflect just this sort of uncertainty as to the future of the railroads among bankers.

The Short-Line Question

SOME encouragement for those who look to railroad consolidation as one way of improving conditions in the railroad field may be found in the Interstate Commerce Commission's decision as to the amount to be paid by the New York Central for the Boyne City, Gaylord & Alpena R.R. Although arbitrators had set a price of $1,393,000 upon the railroad, the commission cut the amount that the Central should now pay to $230,000. Four commissioners even went so far in a dissenting opinion as to express the view that the railroad had outlived its usefulness. What value railroad consolidation may hold for the public generally has hitherto seemed hopeless of realization because the short-line question could not be settled satisfactorily. If the present depression demonstrates that many of such lines have little value except as scrap it may bring some indirect return by building up a sounder railroad system.

Credit Not at Work

SUCH assistance to construction as is represented in the New York Central loan is doubly valuable because contract awards continue disappointingly small. The latest weekly reports indicate hardly as much as normal seasonal acceleration—if it be possible to speak of a normal effect in so irregular a matter as contract lettings. Up to the present, then, the release of credit accomplished by putting United States Treasury support behind the banks has not been effective in activating construction. Since neither manufacture nor trade is showing the looked-for improvement, and the employment situation is getting no better, it is impossible to avoid the conclusion that the freed credit is not yet at work. It may be that a month is too short a time for results, but unless a decided change appears in the next three or four weeks the prospects of getting some of the idle back into their jobs this year will not be good. The situation as it now stands gives support to the view that feeding credit into the top of the economic structure is not enough, and that it must be supplemented by providing work and earning power near the base if industry is to be soon revived.

Business Follows Construction

REVIVING construction would revive business, as we have repeatedly pointed out; and by the same token declining construction is bound to injure business. Present trade figures seem to contain proof of this and to support the prediction that curtailment of public-works construction would be harmful to purchasing power and trade by increasing unemployment. Just now we witness a puzzling sluggishness of all the business indicators, a

disappointing retail trade, and a decline in power consumption. These facts were preceded by heavy cuts in public-improvement operations, which cuts deprived many men of their jobs and caused many others to fear for their jobs. Everyone knows that such men will not buy beyond bare necessity nor will they enter into new commitments. Trade is bound to lag. Every additional stoppage of public works means more of this personal retrenchment, and by cutting down the demand for clothing, furniture and steel, in fact for everything which industry produces, it will have multiplied effect on employment and business activity. The condition that has been created by the sharp campaign of the last three months against continued public-improvement work is warning of even more serious effects if the present trend is not quickly reversed.

Steel Breakwaters

CELLULAR structures of interlocking steel sheet-piles filled with quarry stone and capped with concrete or stone flags have made noticeable progress during the last two years as substitutes for the time-honored rubble-mound, concrete-caisson and timber-crib substructures for seawalls and breakwaters in Great Lakes harbor work. The latest of these steel structures is perhaps the long seawall which is the striking part of the construction of the Lincoln Park extension. Indeed, Chicago and the Lake Michigan ports that lie within the area of its metropolitan influence are the only ones so far which have undertaken the new type of construction. Their pioneering deserves praise. While it has not advanced far enough to prove the sufficiency of steel piling to take wave shock and ice thrust for continued seasons, no obvious strength inferiority to older types of construction has yet been disclosed. There remain to be determined questions of corrosion, grip afforded for ice action, scour and undermining and comparative cost. Confidence that these problems will be solved is strengthened by the fact that the steel breakwater is being developed by some of the most experienced designers in lake-harbor engineering.

Advance in Reinforcing Pavement

CONCEPTIONS of steel reinforcement as a means of increasing the beam strength of a concrete paving slab no longer prevail in highway practice. The woven mesh or grid of steel is now considered mainly a means of controlling cracks. The location of the plane of reinforcement in the slab is therefore fixed by different considerations than formerly, when it was sought to strengthen the slab against bending. But the precision of this location and the true plane of the steel are no less definite requirements. Indeed, bends in the mesh and kinks in the wires are possibly more detrimental to perfect functioning of the steel as a crack preventive than as a means of increasing flexural strength. The problem of accurate steel placement has consequently become exceedingly important in concrete pavement construction and the solutions have been given much thought. A review of methods in this issue indicates that the method most favored involves a return to two-layer construction, but not the former two-course arrangement of base and wearing course separated by a distinct bond plane. With rapid concrete placing, the two-layer construction is so managed as to avoid any bond plane and to produce a slab as truly monolithic as obtained in one-layer construction. With small slabs then, two-layer construction guarantees perfect location of reinforcement.

The Skyscraper's Spokesman

ELOQUENT interpreter of the place of the skyscraper in the city life of today, William A. Starrett taken away prematurely by the driving pressure of his manifold activities, leaves a gap in the world of building that is hard to fill. He lived his working life in the period during which most of the marvelous development of the tall-building occurred, and throughout that period was active in great undertakings in this field. Participation in such lasting achievements as the erection of the Bank of Manhattan Building in less than a year and the still greater Empire State Building, is fame enough for any man; yet even beyond his work in these undertakings Col. Starrett won the greater distinction of making the skyscraper articulate in book and article that carried throughout the country his enthusiasm for the city's great structures and his faith in their meaning and their future.

For the Long Pull

THE coming of spring brings to those who have been devoting attention to unemployment among engineers throughout the winter a realization that their task will not be done when warm weather comes, as they had hoped. Spring and summer doubtless will bring a lightening of their burden, may even remove it for the time being, but there is little reason to believe that the following winter will not restore the problem.

The situation needs to be faced squarely. Employment conditions among engineers have not improved since the first of the year. A few of those who were unemployed at the opening of the past winter have found permanent employment, but many others have been thrown out of work, chiefly through cuts in municipal construction operations. By next winter many of these men may be in need of help. No amount of revival in business during the next few months can be expected to provide engineering jobs for all of these men in addition to jobs for the ones now out of work or in temporary relief jobs.

Two facts stand out. *First*, under the conditions set forth, every effort needs to be made by engineers out of work to find permanent work outside of engineering rather than temporary engineering jobs. *Second*, for the aid of those who are unable to find either kind of work during the summer months the relief organizations must lay their plans for more effective work next winter. Last fall the unemployment relief problem was new; planning by engineers did not, in most instances, get under way until after other relief agencies had begun raising funds, thus diverting contributions that might have gone into relief for engineers. Planning also was faulty, through lack of experience. Knowledge of who were the logical people to approach for contributions was unavailable, or else quite inaccurate, and too little attention was paid to sifting the men who applied for relief.

If the fact is thoroughly understood that relief work will have to be taken up in the fall, even though it is not carried on through the summer, more efficient and

effective work can be planned for next winter. What looked last fall like a steep short hill which could be surmounted by a quick application of brute strength is now seen to be a long pull requiring the best use of all forces at the command of those who have undertaken to reach the top.

Taxes for Services

TAX reduction is among the day's chief themes of discussion. The hard-pressed taxpayer feels that his burden should and must be lightened, and his demands have been met by the officials of many cities throughout the country. Leaders of civic bodies, chambers of commerce men and similar spokesmen of business also have been urging municipal economy and lowered taxes. Last but not least vociferous, real-estate promoters are among the protestants, though their essential interests depend primarily on the public services and public improvements which would be jeopardized by budget reductions.

Great sympathy is due the individual taxpayer. He is short of money, and his job may be gone or soon going; the family must be fed and the interest on the mortgage must be paid promptly. Neither the grocer nor the mortgagee is amenable to political persuasion or can be moved by protests and strikes, but the tax bill is different, being always much larger than the service which the citizen believes he obtains, and being prepared and collected by men whom he elects and who in theory are his servants. There is less reason for sympathizing with the attitude of civic leaders, who purpose to curtail the necessary operations of the community which they lead and whose interest they profess to serve.

Much may be learned about the questions at issue in these tax-reduction campaigns by reading C. A. Dykstra's review of the relation between community functioning and cost. Earlier articles of the same series have brought to light the great increase in service which modern city existence necessarily entails, and the extensive influence of rising price levels on the tax bill. Mr. Dykstra now supplements this information by a practical discussion of essential municipal services and the expenditures which they involve. He throws out a challenge to objectors to show what services should be reduced.

Such practical approach to the problem of city costs is badly needed. If tax protests are to be anything more than idle complaint, it is necessary to show definitely wherein city services should and can be cut. To discuss the question on the basis of momentary expediency is dangerous, for city operation is a going business and cannot be interrupted or suddenly reduced without serious hazard. We must find what services can be cut or abolished permanently, or we have not met the issue.

We must go even farther, for the service needs and therefore the cost of providing them are greater in hard times than in good. We must find how the municipal service and the city's improvement program can be reduced more heavily in prosperous times than now, and how a surplus of tax income can be collected in the good years and laid by to assist in giving the larger amount of service necessary in bad years—the additional charity, police and hospital services, and the emergency construction to provide work for the men whom private business has dropped from its payrolls.

Civic leaders, real-estate men and other citizens as well have a definite opportunity to contribute to their community's welfare in undertaking serious study of these questions. There is no readymade answer. Mere demands for tax reduction, for wage cuts and personnel decreases will not do. Nor will a demand for wholesale discontinuance of improvement operations do aught but make matters worse. Sincere and intensive study is necessary. Mr. Dykstra's exposition is a demand for an answer, and it brings out clearly that practical studies of municipal cost reduction are more profitable than emotional and unreasoning tax-strike movements.

An Equipment Accomplishment

LEVEE building, in its most notable development for flood protection on the Mississippi River, is the creation of equipment. Construction initiative and ingenuity have been displayed chiefly in directing machines. Management has improved particularly in borrowpit preparation and careful drainage, but even in these advances equipment requirements have led, subject only to the need for stability and watertightness of the embankment. Equipment is by every count the dominating agency of modern levee building.

This superiority of the machine in levee earthwork is expressed in a group of articles to be published at intervals during the following months. The article on tower excavators in this issue appropriately inaugurates this undertaking. The slackline cableway excavator, known on the river work as the tower excavator, is essentially the creation of levee work on the Mississippi. None of the other successful machines has this origin: their development began and matured elsewhere and the levee work has only particularized their application. But the slackline cableway excavator matured on the levee work and then invaded other fields of earthmoving.

Let it be added that the idea did not originate on the Mississippi levees, but was born long before its application there. Possibly it began in the Chicago Drainage Canal operations, the mother of so many new inventions and modifications of equipment for earth and rock excavation. It is known that an improvised slackline cableway excavator was successfully moving earth on the Chicago operation in 1895-96. The traveling-tower slackline was, however, truly a levee development, and levee construction led to the major improvement and perfection of this machine as an earthmoving device.

The tower excavator as pictured on another page epitomizes the vast change in equipment invention and practice that has taken place since the first machines were built for the 1914 levee section. The slender strength of steel has replaced massive timber framing; steam power has given way to the internal combustion engine and electric motor; automatic bucket-speed control takes the place of the quickness of hand and eye of human operators; the all-direction mobility of crawler tractions has replaced the straight-line movement of trucks on rails, and tower heights, bucket capacities and cable spans have about doubled. In every manifestation of the talent of the mechanical engineer the present tower excavator is a marvelous refinement of the original machine, but the fundamental excavating principle remains unchanged. How perfectly this was envisioned at the beginning is indicated by the fact that despite their mechanical obsolescence the old machines of 1914-18 are still building levees rapidly and cheaply.

Cities Provide Essential Services at Low Cost

High value is received for taxes—Municipal enterprise leads the way in stabilization, but a long-time program of public works is essential for proper efficiency

By C. A. Dykstra
City Manager, Cincinnati, Ohio

AS CITY MANAGER of Cincinnati, Clarence A. Dykstra, the author of this article, is in a particularly advantageous position to discuss municipal government. Cincinnati is the largest American city having a city manager, and during the six years in which the plan has been in effect it has acquired an enviable reputation for being well governed. First, under Col. C. O. Sherrill as city manager, and during the past two years under Mr. Dykstra, discharge of municipal functions in Cincinnati has gained steadily in efficiency. Mr. Dykstra himself is ably fitted to discuss municipal government in general, as all of his training and activities were in this field prior to his going to Cincinnati from the University of California at Los Angeles, where he was professor of government as well as director of personnel and efficiency for the Los Angeles department of water and power. Mr. Dykstra has also been professor of political science at the University of Kansas, secretary of the Citizens League of Cleveland, secretary of the City Club of Chicago and secretary of the City Club of Los Angeles. His analysis of municipal finance in this article commends itself to every engineer in or out of public service.
—EDITOR.

A YEAR AGO all of our governmental agencies from federal to local were being importuned to speed up their programs of public works. Citizens of all classes criticised the authorities for taking too long to get an accelerated program of public works under way. The principle was set up that in times of depression government should take up the slack in private industry by well-planned public undertakings.

Taxpayers advocate retrenchment

Today opinions are quite otherwise. Taxpayers, individual and corporate, acting singly and through their manifold civic, business and industrial associations, are saying to governmental authorities, "Now is the time to reduce expenditures and stop or delay public works' programs." In view of these two attitudes held so widely within the short space of a year, it seems evident that the implications and benefits of public expenditures are not generally understood. A wider knowledge of the relation between our citizenship and the cooperative enterprise we call government is needed. Certainly, those who talk of the impact of government upon taxpayers and of citizens upon government ought not to run with the tide, whether it is coming in or going out.

The unfortunate situation that exists revolves around the word "taxes." A typical American jest through the years has been, "Nothing is certain but death and taxes." The public takes the position that, whatever other expenditures it may deny itself, taxes remain an inevitable expense. The fact that they are assessed and collected by governmental agencies throws a burden upon public officials that has an unpleasant result in the relations between them and the taxpaying public.

There grows up a general assumption on the part of taxpayers that public officials are interested in nothing so much as in spending public money, and by the same token in raising taxes. But in private business and in our individual lives we are trying to reduce expenditures, which is the very opposite of what we think is the trend of public effort. And so the public authorities are placed on the defensive in the present crisis, and those we call taxpayers are cast in the role of critics.

There is supposed to be some continuing conflict between these two groups. Furthermore, a failure on the part of government agents to guard the welfare of those who pay taxes is assumed. It is for this reason that taxpaying groups attack and spending authorities defend.

Fundamental thinking needed

At this time, with the public mind what it is, it is almost impossible to get intelligent consideration of taxation and public expenditures. Most of the declamations to the public on this subject are destructive rather than constructive. It is of great interest to those of us who are involved in this problem of public expenditure to find *Engineering News-Record* attempting to direct fundamental thinking in this field.

Speaking to the National Tax Association in Atlanta last October, the writer asked certain questions on public expenditure that he considered pertinent. They ran as follows:

Do the increased costs of public service apply to the same services, to increased services or to better services?

Are they due to the desire of public officials, to the demand of the body of our citizenship, to the demand of special groups or to the increases in prices, wages and overhead costs?

Have these increases any relation to increased costs in all business and industry or to higher standards of living?

Do these increases harm or hurt business, or do they mean additional buying power at any point?

Do they affect employment conditions, do they check or encourage prosperity?

Is it sound that a city or a state invest in more and more services and more and more goods?

Unless we answer such questions as these, we do not get very far in any discussion of what passes under the name of governmental costs. I have looked in vain in the publications of taxpayers' leagues and other organized bodies in protest for a real analysis of any of the questions here raised. Usually such studies as have been made for the organizations point out that tax bills are getting larger, that appraisals are being increased, that taxing activities are entering new fields, and that government is by one process or another decorating itself with needless services. In the last analysis this indicates, so the reports say, that we are in danger of accepting some mild form of socialism.

The unemployment problem

A new problem has been forced upon governmental authorities in the last year or two. It, too, involves increasingly larger expenditures. Our governmental agencies have executed almost every conceivable maneuver to keep from being asked to do something about employment or unemployment. Meanwhile business, industry, social organizations and taxpayers insist that local governments particularly must spend more money to take care of the emergency that is facing us on all fronts.

No matter how rugged our individualism may be or how widespread our praise of this individualism, in times of stress we seem to turn to public authorities for relief. The rather slow and continuous requests for relief of various kinds from day to day, all of which spring from the same fundamental urge, are not recognized as normal or inevitable. But we do see the logic of cooperative undertakings when times are hard and we can find no other way out of our difficulties.

Furthermore, in the cooperative undertakings that we call government, those who control are the voters themselves, and hence the governmental agency whose aid is invoked acts under a mandate of the people. It has certainly been true that for several years government authorities have been spending time and energy to dissuade large and special groups of citizens from asking too much of government.

Some specific criticisms

One more assumption needs notice—that which insists that public services are unproductive. Just why we should preach to consumers generally that business should go on as usual, and in the same breath ask for a restriction in governmental activities, is hard to fathom. The bulk of government service, particularly in local governments, is the

activity of the personnel through which government functions. The one greatest element of cost is salaries and wages. The relation, therefore, between the community and its buying power depends in some degree on the purchasing activities of city employees. If it is possible to stabilize the industry that we may call government, we have maintained one operation at least on a 100 per cent basis. This is the thing we are striving for in all industry.

If it were possible to single out governmental services of 50 years ago and to compare the costs of such services with the costs of the same services today, it might be possible to show that these per-capita costs are not rising alarmingly. The trouble with most statistical analyses of government costs is their utter lack of perspective. A categorical statement that the cost of government in New York City today runs beyond the total expenditure by the federal government in the time of President Jackson is interesting, but it means nothing. When your grandfather tells you that in his boyhood the total family expenditures ran to $200 or $300 a year, it sheds little light upon the problem of expenditure in the family of a carpenter who lives in Chicago in 1932.

Shifting service responsibilities

The thing that needs to be pointed out in any consideration of public expenditures today is that there has been a continual shifting of time-honored individual expenditures into the field of public expenditures. There are so many services that we agree are individually and socially desirable but that cannot by any chance yield a money profit that we continue to project governmental authority into these fields. In the last analysis we do this because we find it is a way to save money.

But the trouble is that if we save $25 in our personal expense by getting the government to give us the same service for $3, we credit the savings to our personal account and resent the increase in government costs. Thus, a per-capita expenditure of $3 a year for the services of a fire department unquestionably yields the citizen a much higher per-capita saving in insurance rates, yet this saving is never given prominence in discussions of the rising cost of government.

Public versus private waste

I do not suggest that public officials are never extravagant. But the same charge of extravagance can be brought against people in general and against business, industry, and professional life. The President of the United States time and again has pointed out the waste that inheres in modern industry. Such wastes are due to duplication of effort, heavy overheads, what we call public relations and many other items. I should be entirely willing to defend the thesis that government costs are higher than they ought to be because we still insist on having too many separate individual governing and taxing authorities; but to prove that costs are too high in each of these agencies is a very different and a very difficult matter.

Just now we are concerned with the question of whether it is socially and economically desirable to throw out of the window our program of public works during the period of stress through which we are living. I say no! I think it should be said, however, that in the long run much acceleration of public-works programs in times of *ordinary depression* is undesirable.

My feeling is that a public-works program, as any other program, should have the essential elements of stability and continuity for which we are pleading quite generally. If we make the public-works industries seasonal and occasional, we do the very thing that makes private industries sick. What we need is a long-time program of public works. Such a program will include, of course, proposed methods of financing.

Cincinnati plans ahead

This is what we have tried to do in Cincinnati and Hamilton County. A coordinated bond-program committee representing the city, the county and the school board has been working harmoniously and methodically for several years upon a five-year program. This program is calculated continuously for five years in the future and is never a four-year or a three-year program.

Even now there is set up on the books of this committee the proposed capital expenditures for public works for five years in the future, and the approximate amount to be expended yearly is agreed to. It is quite possible to know, therefore, what sums of money are to be available for capital expenditures and what tax rate will be necessary to finance these expenditures. Although there are millions of dollars voted in authorized bond issues, this community expects to spend these authorizations with an eye on the tax levy necessary for interest and amortization charges. It is attempting also to bring down slowly but surely the total bonded indebtedness of the community. The work of this committee and of the finance authorities of the various governmental agencies has cut both our bond totals and our tax levy for debt purposes. Table I pictures these results.

City expenditures analyzed

Analysis of public expenditures at Cincinnati may be of value to those who are thinking in terms of governmental costs. (See Table II.) The anticipated general governmental expenditures for 1932 for this city total $9,064,306, or $19.93 per capita. Out of special revenues derived from gasoline and motor-license taxes the city expects to receive $1,181,330, an additional per-capita amount of $2.62. This latter item might well be considered as a special utility payment for the use of improved highways and for the savings in maintenance costs on motor cars. There should be no question in anyone's mind that this expenditure is saved many times over to the ordinary motorist in minor repairs and in depreciation on his equipment.

In this compilation waterworks is

TAXES—FOR WHAT?

Prominent among the day's catchwords are lower taxes, balanced budgets and municipal extravagance. And of these municipal extravagance is shouted most loudly and most often. Even influential citizens and leaders in business join in denouncing the city's excessive spending. But the accusers bring forward few facts. They have not studied municipal expenditures.

Mr. Dykstra has studied them for years. He is intimately familiar with municipal services and speaks of them authoritatively and truthfully — no one who knows his career can doubt this!

City costs are low, Mr. Dykstra finds, though they can be made still lower by thorough advance planning. The costs of mere government are quite minor. Most of the tax money is payment for services that the citizen formerly bought directly but which he now insists must be furnished him by the city.

Are we to go back to the ways of the primitive communities? Will the citizen resume the responsibility of providing his own protection, his own fire service? Mr. Dykstra's simple statement of Cincinnati's services and costs will enable the reader to formulate the answer.

TABLE I — DECREASING DEBTS AND DEBT-SERVICE LEVIES AT CINCINNATI
(Tax duplicate and levy per $1,000 of assessed valuation for debt service and net non-self-supporting bonded debt)

Year	Tax Duplicate	Debt-Service City Levy	Debt-Service Total Levy (County, Schools, and City)	Net-Non-Self-Supporting Bonded Debt of the City
1927	$1,039,600,600	$4.353	$5.753	$32,814,411
1928	1,061,008,780	4.222	6.532	30,193,537
1929	1,086,622,460	3.760	5.590	31,171,529
1930	1,108,557,500	3.220	5.110	30,893,801
1931	1,125,927,580	3.010	5.150	30,091,539

TABLE II—ANALYSIS OF GENERAL CITY COSTS IN CINCINNATI

Activity Group	Amount Allotted	Per-Capita Cost
Legislative	$184,167	$0.41
Council, mayor, elections		
Administrative	262,771	0.59
City manager, legal, administration of public works, personnel		
Financial	157,352	0.35
Purchasing, treasurer, auditor		
Judicial	130,416	0.29
Municipal court		
Staff services	336,732	0.61
Maintenance of property and motor transport		
Education	599,100	1.32
University of Cincinnati		
Protection to person and property	2,992,725	6.62
Police, fire, weights and measures		
Conservation of health and welfare	2,699,487	5.99
Health board, hospital, parks, welfare, waste collection, street and sewer cleaning		
Engineering services	302,823	0.67
Highway, sewer and city-plan engineering		
Public utility service	618,253	1.35
Street and traffic lighting and airport		
Employee pensions	705,480	1.57
Judgments and contingencies	75,000	0.16
Total	$9,064,306	$19.93

excluded, since that is a self-supporting utility and is in no sense or at any point a charge upon the taxpayer. There should be included, however, the item derived from taxation for general sinking-fund purposes, $3,173,620, or a per-capita cost of $7.02. It has been noted already that this item is decreasing steadily.

A careful study of Table II indicates that the so-called governmental services of American tradition are after all a minor item in the public expenditure of any local government. Taken together, the legislative, administrative, financial and judicial services account for about 8 per cent of the total cost.

The largest single item has to do with the protection of persons and property, and it would be a simple matter to challenge anyone as an individual, or any group as a corporation, to bring down these service costs to a figure that would even approach the cooperative or municipal cost. Consider the item of police protection as against private watchman service. The citizen of Cincinnati is in touch through his police radio station with every patrol and scout car in the city, for a per-capita cost of $2.91. All he has to do is to reach for his telephone, and within two or three minutes he has all the possible police assistance he may need.

Take the item of fire, and note that the per-capita cost is but $3. This service comes to the citizen as many times in the year as it may be called for. It reduces his fire hazard to the absolute minimum, and the life-saving squad saves the lives of members of his family regularly in cases of drowning, asphyxiation, gas poisoning and other emergencies.

The next largest item in our public-expenditure program, running almost to 30 per cent of the total, has to do with the social services, conservation of health and welfare. For these services the average citizen pays a per-capita cost of $5.99. For that sum he has all the protection given by the board of health, the use of the general hospital, the use of city parks, the facilities of the recreation commission and the tremendous aid, particularly in such a period of depression as now exists, of the welfare department—which at present is turning its whole attention to the problem of unemployment relief.

Wastes of all kinds are collected and disposed of, including back-door collection, for the small per-capita cost of $1.15. All streets and sewers are cleaned regularly and thoroughly.

The citizen in Cincinnati pays $1.57 per year to provide for the pensions of its employees. Of this amount the great bulk goes to the policemen and firemen. One of the tragic situations in which we now find ourselves is that industry in general has not made provision for retirement allowances and for periods of unemployment. *In this respect the public authorities are showing the way.*

Another of our considerable items has to do with public-utility services in general. It costs a citizen of this city $1.31 a year for all street and traffic lighting and only $0.04 a year to run the airport.

In the discussion of public expenditures for Cincinnati no account has been taken of the costs of public education except as indicated by the item "University of Cincinnati." Ordinary educational expenses are borne by the school board, a separate taxing body. Apparently no expenditures have been more gladly borne by the American people than those for public education, and no bonds are so overwhelmingly voted as those for educational equipment. In any event, we have no right to set down public expenditures for the purpose of education as governmental costs. Not until well along in the 19th century did Americans agree finally to undertake an educational program and charge the expense to taxes.

Cooperative services

What I have been at pains to say in this article is that we must begin sometime to distinguish between what we call governmental costs and public expenditures. Perhaps 5 per cent of our so-called governmental costs deals with functions that we originally thought should be chargeable to local government. *All the rest of our expenditures should be classified as public services which we demand* and which we have agreed are easiest and most economically collected and paid for in terms of taxes. In proportion as we decide to take our money out of our tax pocket rather than out of our private expenditure pocket, taxes go up.

Since we have decided to render these services through a cooperative agency that we call government, we should not be alarmed by this fact. We can throw overboard the bulk of this expense any time that we decide as citizens to do our own policing, our own fire-fighting, our own street work, dispose of our own wastes and sell our park and recreational grounds and facilities. Should we suggest, however, to the ordinary mother of the ordinary community that the yearly per-capita expenditure for public recreation (23c. in Cincinnati) should be discontinued and this money used for one moving picture ticket, there would be serious domestic disturbances. It means something to the mother to know that her children are being supervised in whole some play for a whole season for such a small amount.

Could we have a realistic analysis made of the program of public expenditure in any local community and separate this analysis from our time-honored attitude toward the subject we call taxes, we would for the first time bring home clearly to the average citizen what is actually involved in the subject that we call—so loosely—governmental cost.

Bordeaux-Marseilles Canal Project

Approval by the French parliament late last year of part of the government's national development program (programme d'outillage nationale) gives new importance to the project for a ship canal connecting the Atlantic and Mediterranean on the line extending from Bordeaux to Narbonne and Marseilles. This project, which would involve about a half billion dollars and more than a billion and a quarter cubic yards of earth movement, is projected by a private company that is seeking a concession from the government. It is the largest active canal project now under consideration anywhere. A total canal length of about 250 miles would be involved. The line would go up the Gironde about 10 miles beyond Bordeaux, then continue southeasterly south of the Garonne River to a few miles north of Toulouse, where it would cross the Garonne and the old 200-ton Canal du Midi; thence generally parallel to the old canal, reaching the Mediterranean at Narbonne. The summit level, in the Toulouse region, would be at about 487 ft. (148.5 m.) elevation and would be reached by seven groups of locks on either side, each lock consisting of four parallel chambers of different sizes, ranging from 120x15x8 m. to 390x50x13.5 m. The water supply, from the Garonne, the Tarn, the Lot and the Aude, is believed to be ample. Shipping distances from the English Channel to the Mediterranean would be decreased by the new canal by amounts approaching 1,000 miles.

Concrete-Road Resurfacing Slab Laid on Sand Cushion

Sand bedding course cushions new 4-in. slab surface on old concrete pavement—High-early-strength cement reduced traffic delays

By C. S. Mullen
Chief Engineer, Department of Highways, Richmond, Va.

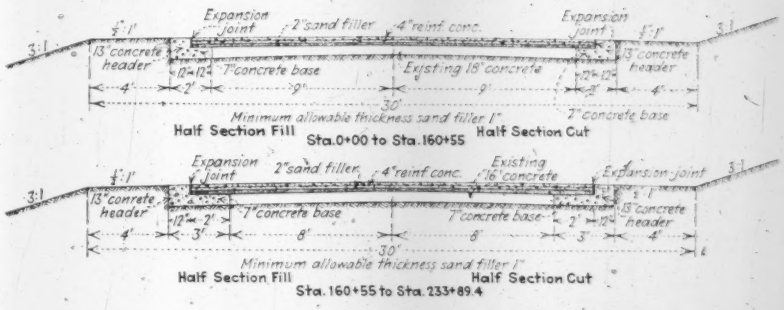
FEATURES believed to be unusual in resurfacing concrete pavements were employed last year in reconstructing the old Virginia highway through the sand dunes bordering Chesapeake Bay from Lynnhaven Inlet to Cape Henry, the point of the first landing of the English colonists in 1607. The section of road embraced in the resurfacing project is 4.42 miles long and consisted of a plain concrete pavement, 16 and 18 ft. wide, and averaging 6 in. deep. The surface was so rough that speeds greater than 25 miles an hour were exceedingly uncomfortable. Due to its use as one of the main roads to the ocean resort of Virginia Beach, there was an insistent demand for its reconstruction.

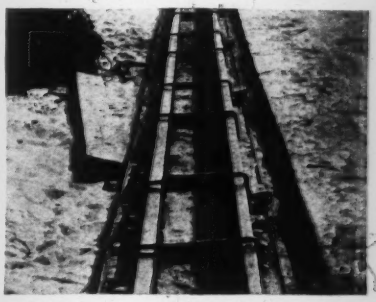
A study of conditions indicated the necessity for widening the existing road and of smoothing up its surface so it could be used as a base course for a new surface. Alternate designs were decided on, and competitive bids were received March 31, 1931. One design provided for widening to 22 ft. with concrete base and headers, smoothing up the existing pavement and resurfacing between the headers for a width of 20 ft. with rock asphalt having a minimum depth of 1 in. The alternate design is shown in the accompanying sketch. It provided, as in the first design, for widening to 22 ft. with concrete base and header, but substituted a 4-in. reinforced-concrete slab on a sand cushion for the rock asphalt.

The bid on the concrete slab was $13,000 lower than on rock asphalt, and it was therefore accepted and the contract awarded to the Brooke Construction Co., of Norfolk, Va.

Two variations in this design were made at the request of the Bureau of Public Roads. One section, 200 ft. long, was laid directly on the old concrete pavement without the sand cushion. One section, 500 ft. long, was laid on a bituminous mastic mixture composed of sand and refined tar in the proportion of 92 to 95 per cent sand and 8 to 5 per cent of tar, by volume. This cushion was thoroughly compacted by rolling before the concrete was deposited.

Types of road widening and resurfacing with a reinforced slab on a sand cushion.



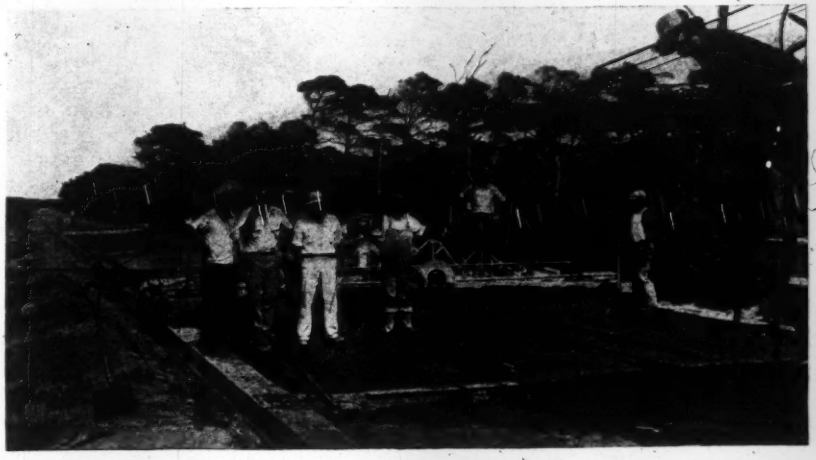


Forms set for widening strips and side headers for concrete road.

Use of high-early-strength cement

The reconstruction work necessitated closing the road to traffic, and the only available detour was a road that entered the project one-half mile south of its beginning. In order that traffic should be inconvenienced as little as possible, high-early-strength cement was used throughout in this half-mile section, and it was opened to traffic 24 hours after the last concrete had been poured.

Again, as the completion of the project approached, high-early-strength cement was used so that the entire project could be opened shortly after the last concrete was in place. The headers were used as forms from which to finish the reinforced slab; and in order that the surfacing should not be delayed, high-early-strength cement was used in the base and header work, thus saving the contractor the delay that would have resulted from the curing period if ordinary cement had been used, and also reducing the number of forms necessary to carry on the work.

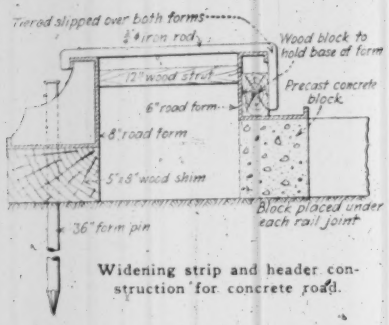


Concreting two-course reinforced-concrete resurfacing slab.

Materials and construction

The coarse aggregate was washed gravel. The mix was designed on a cement factor of 1.4, and the fine and coarse aggregates were proportioned by weight. The mix for the base course and header was 1 part cement to 7½ parts fine and coarse aggregate. The reinforcement was of the wire-mat type, weighing 42 lb. per 100 sq.ft. The mat was composed of 6-gage wire, spaced 6 in. apart and made up in sheets 19½ ft. wide.

The base course and headers were, of course, constructed first. The development of proper forms for this part of the work caused some difficulty, but after trying several methods the one



Widening strip and header construction for concrete road.

shown in the accompanying sketch was adopted and proved entirely satisfactory.

As the construction of the base course and headers progressed, the old pavement was thoroughly cleaned, and all cracks and all joints between the old and new concrete were carefully sealed with an asphaltic cement. This was done to prevent loss and displacement of the sand cushion.

Sand from dunes along the road was then deposited between the headers, thoroughly inundated and struck off by a properly shaped templet to a depth of 4 in. below the top of the headers.

The pavement concrete was then deposited and struck off to a depth of 2 in. The reinforcing mats were then placed, lapping 12 in.; and at intervals of 105 ft. a 3-in. gap was left between the mats for the purpose of introducing planes of weakness. On the section where the bituminous-mastic mixture was used the planes of weakness were placed at intervals of 45 ft.

The reinforcement was temporarily held in place by four sections of 30-lb. rail, which were withdrawn after the finishing course of concrete was deposited. The surface was completed with a finishing machine that was run on the headers as a guide. The reinforced slab was separated from the headers by strips of expansion-joint material ½ in. thick.

The planes of weakness were formed by forcing into the surface over the gaps in the reinforcement a steel plate, which, when withdrawn, left a crack 2 in. deep and ⅛ in. wide. These cracks were sealed with asphalt joint filler.

The entire project was completed and opened to traffic on Aug. 19. Early in November a careful inspection was made. No transverse or longitudinal cracks were discovered except in two sections. On the 200-ft. section where the new concrete was laid in direct contact with the old pavement there were nine transverse cracks, not including the planes of weakness, and several longitudinal cracks. On one section laid on sand cushion and adjacent to the mastic-cushion section, three transverse cracks had developed. There was no evidence of any displacement of the sand cushion.

Land Erosion in Indiana Checked by Forestation

EROSION of land occurs to a serious extent in many agricultural states, and its prevention and correction is largely an engineering problem. How this problem is being solved by forestation in Indiana was described in a paper read at the recent meeting of the National Drainage, Conservation and Flood Control Congress by R. F. Wilcox, state forester, and S. R. Sapirie, field engineer, of the Indiana department of conservation. The accompanying view shows a condition which in miniature resembles the "bad lands" of the Missouri and the vast eroded areas of China that have resulted from destruction of the forests. An abstract of this paper follows.

To determine the average loss of soil per acre by erosion, cross-sections were taken on a field in the state forest of Morgan and Monroe counties. These showed a loss of 11,580 cu.yd. per acre, or an average depth of 7.17 ft. The field, shown in the accompanying illustration, has not been in cultivation 45 years and had a fairly uniform slope of 10.8 per cent at the time of its abandonment for agriculture. From an aerial map of the forest taken at 9,600-ft. elevation it was found that 295 acres showed erosion plainly. Taking 50 per cent of the extreme case measured, or 5,790 cu.yd. per acre, the soil loss on the eroded area has been 1,708,050 cu.yd., or enough to cover a square mile 1,656 ft. deep. All the runoff from the test area has poured through a narrow channel on a forested hillside, with no erosion on either side, as the trees, shrubs and herbaceous plants have formed a protective blanket.

Land in Indiana eroded after abandonment of cultivation. Reforestation has completely checked the development of such conditions in many areas.

Forestation to check erosion was tried in the Clark County state forest in 1910 on a gullied slope of about 15 per cent, bare of vegetation and about 40 ft. long. Brush was thrown in the ditches and spread over the surface. Black locust trees were planted about 6 ft. apart. Three years later the brush had rotted away and the trees were about 10 ft. high. In 1920 the trees began to show the effects of the locust-borer insect, and the area was underplanted with white pine, which grew vigorously, as the locust had protected the soil and invigorated it with nitrogen and leaf humus. Native shrubs and vines grew in a similar manner, so that in 1932 there is a complete stand of thicket and forest trees that has completely stopped every trace of soil erosion for the last several years.

With this experience as an object lesson, a crew of men worked for months at the Morgan-Monroe forest, filling gullies with brush and planting black-locust seedlings and pines on the eroded fields. Locust seedlings one year old can be grown at a cost of $2 per thousand by planting the seeds ¼ in. deep in garden beds about May 20 to June 1. One or two weedings in the summer are all the culture they need. The cost of planting the trees is about $5 per acre. Trees cost $2, and the brush cover costs about $5, making the cost of control about $12 per acre of gullies.

Ruhr District Uses Activated Carbon for Taste Removal

Successful use of activated carbon for taste removal is reported from the Ruhr district in Germany by Dr. F. Sierp, of Essen, in *Gas und Wasserfach*, 1931. The city of Hamm has had a plant in satisfactory operation for 2½ years; several other plants are in service. In this district generally the heavy pollution of the river water requires strong chlorination, and filtration does not remove the resulting chlorine-phenol taste; hence the resort to activated carbon. The costs of the treatment are placed at $2.50 per million gallons.

Construction of an Over-Crossing on Steel Piles

California highway structure 1,380 ft. long built on H-piles tested for 30 tons capacity is first major bridge project in state to use welded construction

By Milo S. Farwell

Structural Engineer, Pacific Coast Steel Corp., San Francisco, Calif.

USING welded connections for the first time on a major highway structure in California and featuring a simple framing design resting directly on steel bearing piles, the Bradley overcrossing completed by the division of highways is a notable development in this field of construction. The structure provides a grade separation between a heavily traveled highway entrance to Yosemite National Park and the tracks of the Atchison, Topeka & Santa Fe Ry., near Merced. The entire project cost $109,000, and the structure and decking cost $88,000.

The design was prepared in accordance with standard specifications of the California division of highways and also conforms to the specifications of the American Association of State Highway Officials. As a federal-aid project, the structure was approved by the Bureau of Public Roads. Plans and specifications were prepared on a basis of a welded design with an alternate of riveted connections. The contract was awarded on a basis of the welded design, and the structure was fabricated and erected with this type of construction.

The structure is one of the first overhead crossings built on steel bearing piles. Typical bents consist of four 8-in. 32-lb. H-piles. An exception and a special case is used at the crossing over the tracks, which is supported by a 14-in. 84-lb. H-pile on one side and a similar H-section on the other side, supported by a spread footing of concrete resting on a cluster of redwood piles. The ground profile is practically level, requiring column lengths above ground varying from 0 to 20 ft. Test piles indicated that a penetration of 30 to 35 ft. would be required, making a maximum length of pile of about 55 ft. from tip of pile to superstructure.

Piledriving.—Piledriving equipment consisted of a 3,800-lb. drop hammer operating in false leads 55 ft. long suspended from the boom of a crawler-mounted crane and braced near the bottom with horizontal struts to the frame of the crane. A cast-steel driving head fitted to the leads of the driver maintained proper alignment of the piles during driving.

Foundation material consisted of 15 ft. of topsoil underlain by strata of sand and gravel. Specifications provided that, if the required 30 tons of bearing capacity was not obtained at a penetration of 15 ft., additional bearing capacity was to be secured by attaching short H-sections as scabs on the lower end of the piles. These scabs were to have a minimum length of 2 ft. 10 in. and to be welded to the outside of the pile flanges at the proper position on the pile to penetrate into the hard material. In special cases these scabs were used to permit the use of shorter piles than could be accommodated in the driving leads.

Splices were used for some of the pile sections in the higher bents and were provided by welding plates on both sides of the web and the outside of the flanges. These splice plates were attached to the bottom of the upper section of the pile after the lower section had been driven into the ground. The upper section with plates attached was then set on top of the driven section, the hammer dropped several times to improve splice contact and the welding completed. Driving was then continued until proper penetration was secured. A typical bent called for the four piles to be spaced 6 ft. 11 in. on centers, supporting steel girders, which necessitated that the piles be driven accurately to proper alignment. After driving, the piles were burned off to receive the floor beams.

The piles were protected at ground line with a concrete incasement extending 4 ft. below ground line and 3 ft. above, providing a 3-in. minimum cover

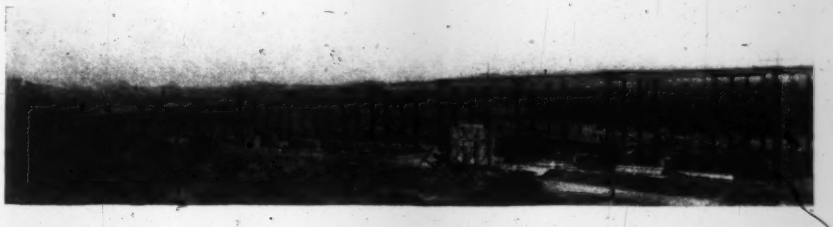


Fig. 2—Part of the Bradley overcrossing showing simple steel framing with H-columns extending directly into the ground as bearing piles.

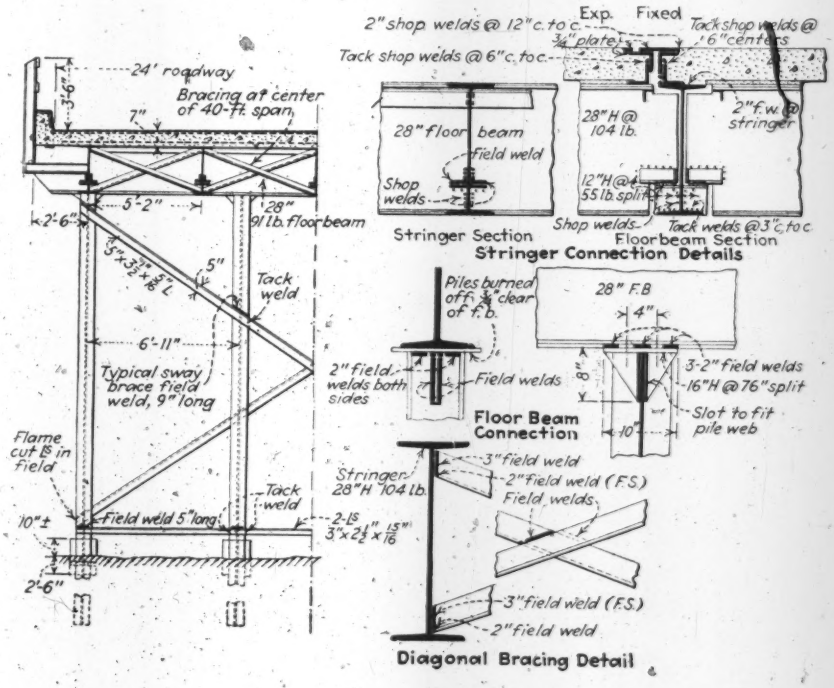


Fig. 1—Typical section indicating welded connections and details. Stringer connection is shown welded as designed, although contractor used rivets.

over the steel. Before shipping, the mill scale was removed from the piles in the shop by sandblasting.

Pile Testing — The *Engineering News* formula was used as a guide in determining safe bearings for the piles specified at 30 tons per pile. Actual carrying capacity was determined by tests operated with load applied by a hydraulic jack. No difficulty was encountered in securing the required bearing area, although the use of scabs was required in 20 per cent of the cases. Individual piles were tested that sustained a load of 60 tons.

The principle involving the bearing capacity of steel H-piles is different from that of the ordinary pile because of the difference in cross-section. The driving of an H-section pile into the ground carries down the earth between the two flanges as the member is driven. This core of earth is compressed as it is carried down to approximately half the original volume, creating an increased bearing value for the pile above that obtained by friction

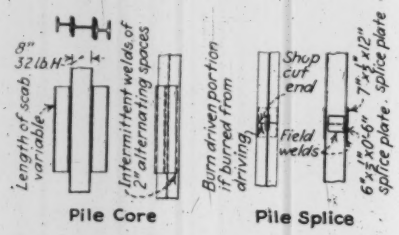


Fig. 3—Detail of pile splice and scabs to increase bearing. Scab detail used to increase pile capacity to 40 tons when pile penetration reaches 25 ft. and a capacity of only 30 tons is available. In making splices, weld was placed above joint, hammer was dropped several times to improve splice contact, and then weld below joint was placed.

on the original section. Providing scabs tends to increase this friction.

Steel Superstructure — The superstructure consisted of 31 steel spans 40 ft. long, and seven 20-ft. tower spans for stiffening. Required vertical clearance over the railroad track was 23 ft. 4 in. Floor beams are 28-in. 91-lb. sections resting directly on top of the piles and carrying five 28-in. 104-lb. stringers. The simple welded diagonal bracing of this floor system is shown in Fig. 1. The bearing of the stringers on the floor beams was made by coping the bottom ends of the stringers to rest on seats made of a 12-in. I-beam section split in T-sections and fastened to the web and top of the bottom flange of the floor beam (detail, Fig. 1). This I-beam section for the bearing seat was inverted, the top side of the section forming the bearing surface for the angles fastened to the stringer.

Superstructure expansion was provided for by means of slotted bolt holes in expansion plates at one end of the stringers. Asbestos sheet packing

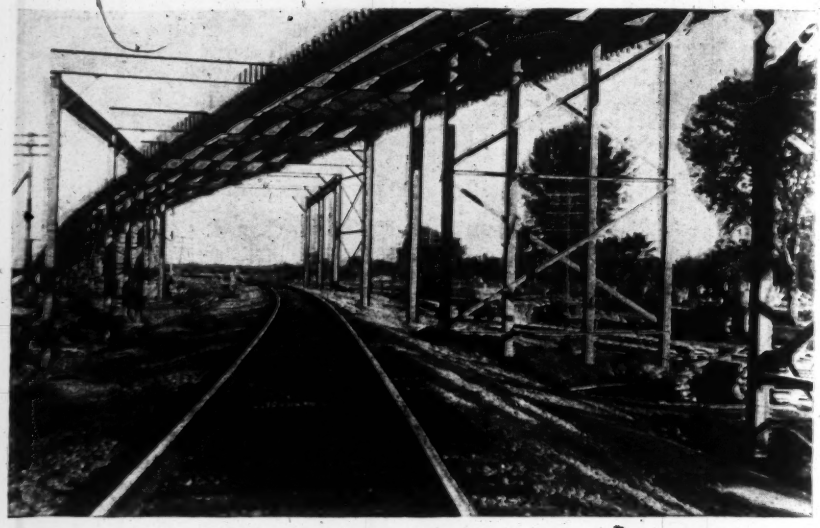


Fig. 4—Special 35-ft. floor beams are used to carry the structure over the railway tracks.

was placed between steel bearing surfaces. The corresponding expansion joint for the concrete slab is shown in Fig. 1.

Crossing the railroad track at an angle of 13 deg. with a required horizontal clearance of 25 ft. between vertical supports, the structure required special framing for four of the 40-ft. spans and for one of the tower sections. Only two vertical supports were used for each set to carry this section of the structure over the tracks, and the skew increased the span of six of the floor beams to 35 ft. (Fig. 4). This necessitated 30- and 36-in. beams, but otherwise the same floor system was used.

The hand rail consisted of 6-in. stanchions at 6 ft. 8 in. centers as uprights and two 5-in. channels as rails. The steel floor system was covered with a reinforced-concrete slab 7 in. thick with a 1-in. crown at the center. The roadway width was 24 ft. with a 12-in. concrete curb at either side. Approach sections are on a 5 per cent grade followed by a 300-ft. length of vertical curve connecting with the central level section.

Welding—The structure is the first major project built by the division of highways to use welded construction exclusively. A minor exception in the present case was the riveting of the connections between stringers and floor beams. Specifications for welding provided for a direct-current electric arc for all connections. Both fillet and butt welds were used, with tack welds specified only for the purpose of assembly. All welds were required to be ⅜-in. full fillets to develop 3,000 lb. per linear inch in tension and shear. Test specimens of welded connections were required to show an average ultimate longitudinal stress of 45,000 lb. per sq.in.

The design of the structure required that most of the welding be done in the field. Current was supplied by portable generators mounted on trucks. Structural members were secured by erection bolts, which remained in place. After final adjustment of the bolts they were given a spot weld and became part of the permanent structure.

Personnel— The overcrossing was built by the state of California under the supervision of the division of highways. Designs were prepared under the direction of C. E. Andrew, state bridge engineer, with H. D. Stover as engineer of design. The resident engineer for the division of highways was C. S. Hamilton. M. B. McGowan, San Francisco, was the general contractor, and the Pacific Coast Engineering Co., of Oakland, fabricated, erected and welded the steel.

Earthquakes in 1930

There were twenty earthquakes of some importance in the United States in 1930, according to the publication "United States Earthquakes, 1930," issued by the U. S. Coast and Geodetic Survey. One, occurring in Louisiana, marked the first time that other than very slight shocks had been felt in that state. Three of the earthquakes did some damage to old buildings in Nevada and California. The more typical shocks occurred in the desert east of San Bernardino and in the region of Lake Tahoe. Two shocks did some damage to buildings in the Cape Mendocino region. The total number of earthquakes in the United States proper, not including those felt over a very small area, was 137, or an average of one every third day. Despite this number, there were no shocks of great importance. The publication contains a list of 26 earthquakes that occurred during the year, of which 21 were beneath the sea and five on land.

Guy Derrick on First Floor Sets Heavy Roof Trusses 100 Ft. in Air

End sections of trusses set as cantilevers supported by temporary posts, and center section filled in on new Girard College chapel in Philadelphia—Stone slab and concrete roof deck dictate use of exceptionally heavy trusses

AN EFFICIENT and rapid building-erection scheme, involving the use of a single guy derrick set on the first floor and moved progressively along the center line of the building, was utilized recently in placing the structural steel in the new chapel of Girard College in Philadelphia. The guy derrick had a capacity of 20 tons, a 120-ft. boom and a 130-ft. mast, and its principal task was to set a series of five roof trusses, weighing from 30 to 45 tons each and varying in length from 80 to 115 ft. There was also required the erection of a number of 10-ton dog-leg roof rafters, as well as the remainder of the columns and floor steel in the structure.

The building is to be of monumental, classical character and is a truncated wedge in plan, 200 ft. long on its central axis, 80 ft. wide at the narrow end and 120 ft. at the wide end. In keeping with the monumental appearance of the building, the sloping sides of the roof are to be covered with 8-in. shingled stones resting on a reinforced-concrete slab. To carry this unusual load over a building entirely devoid of columns in its interior required roof trusses of a massiveness seldom encountered in building construction. The bottom chords of these 25½-ft.-deep trusses are 72 ft. above the floor at the center of the building so that the erection problem was not a simple one. About 1,000 tons of steel was required in the structure.

In studying various erection schemes the ordinary method of assembling the trusses on a tower traveler was discarded because of the height of the trusses above the floor and also because the floor itself is on an incline. The guy-derrick method that was adopted involved the use of two temporary erection supports made up of two heavy columns, later to be used in the building, spliced out to a sufficient length and braced to the wall columns by temporary struts. It will be noted from the accompanying illustrations that the trusses are logically divided into three erection pieces—a cantilever arm at either end and a suspended section between. This division also brought the weight of each pick within the capacity of the guy derrick.

Erection was begun at the small end of the building. The temporary supports

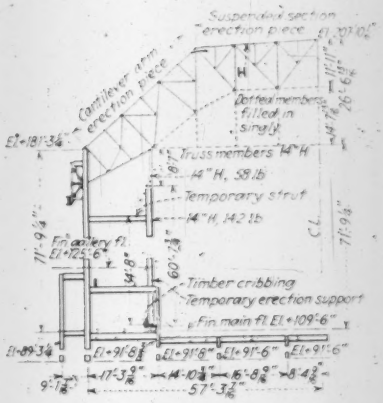


Fig. 2—Cross-section of Girard College chapel steelwork, showing division of heavy roof trusses into erection pieces that were placed by 120-ft.-boom guy derrick resting on the first floor. Temporary erection supports for the cantilever arms are fabricated from the permanent building columns.

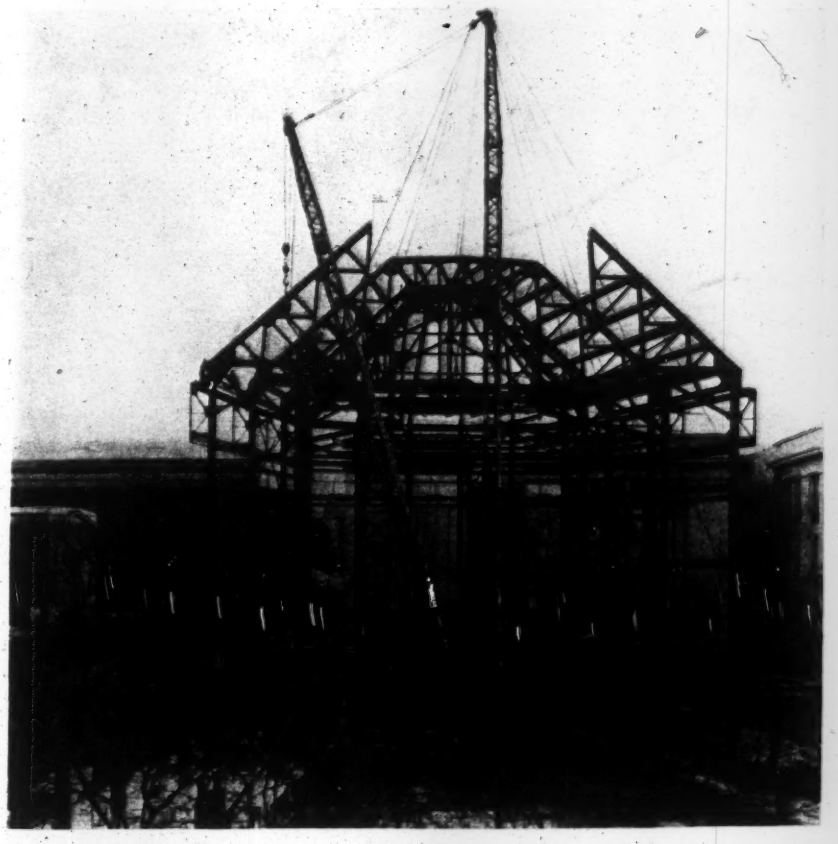


Fig. 1—Erecting a 45-ton roof truss in the new chapel of Girard College in Philadelphia. The guy derrick is setting one of the cantilever-arm erection pieces. Trusses were erected in three sections.

were placed to carry the cantilever arms of the trusses on either side of the building and were set on timber cribbing in which jacks or wedges could be installed, to be used for adjusting the ends of the cantilever arms in making the connections with the center section when it was raised into position.

With the supports erected, the guy derrick from its position in the center of the building lifted the cantilever arms into place, followed with the center section and completed the truss by filling in the several tie-members that join the bottom chords of the cantilever arms across the building. The guy derrick and supports were then moved into position for the next truss, and the operation was repeated. The entire structural steel frame was erected in 75 working days.

The structural-steel frame was fabricated and erected by the Belmont Iron Works, of which Joseph G. Shryock is chief engineer. B. T. Mial, manager of erection, developed the erection scheme. Turner Construction Co., New York, is the general contractor, and the firm of Thomas, Martin & Kilpatrick, Philadelphia, is the architect.

Dry-Seal Waterless Gasholder Erected at Syracuse

Introduced from Germany, where it is known as the Klönne holder, this 6,000,000-cu.ft. piston-type gas tank is largest of its design in the world—Others building at Reading, Pa., and Kalamazoo, Mich.

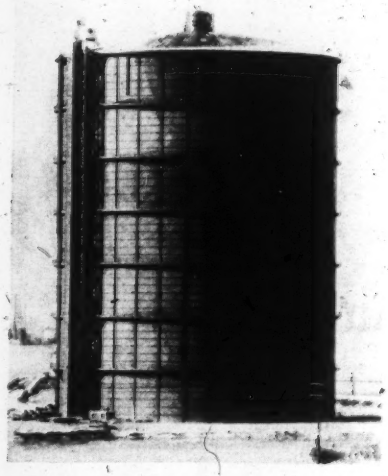


Fig. 2—New 6,000,000-cu.ft. piston-type gasholder at Syracuse, N. Y., differs from previous waterless holders in that it is cylindrical and utilizes a mechanical seal.

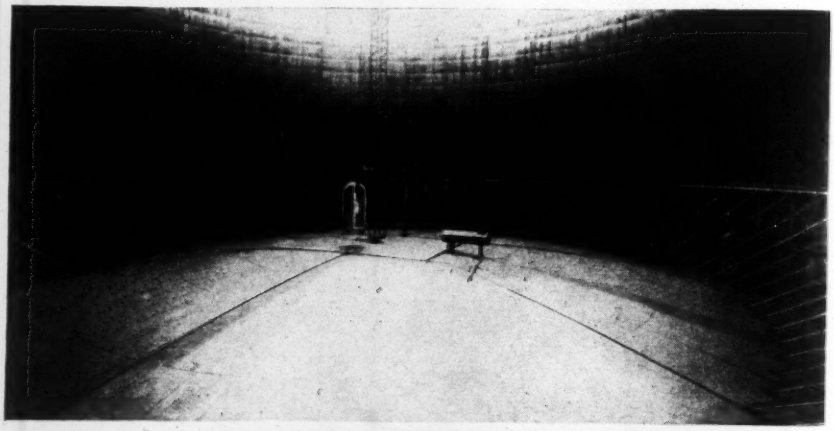
TELESCOPING gasholders, while still the prevalent type, have been supplanted to some degree in recent years by waterless or piston holders, particularly in the larger sizes. Disadvantages of the telescoping holders have been their unsightliness caused by greasy water adhering to the shell and the expensive foundations required for the water tank. Both of these disadvantages are eliminated by the waterless holder, in which the shell remains fixed while a moving piston within confines the gas and gives it the necessary pressure. The heaviest load is that of the piston in its down position, and this requires only a ring foundation of comparatively small size. The largest gasholder yet built is of the piston type and is located in Chicago. It has a capacity of 20,000,000 cu.ft. and a shell 283 ft. in diameter and 405 ft. high. The shells of previously existing piston gasholders in this country have been polygonal in section. The new type holder described in this article has a cylindrical shell and, as a major feature, a non-liquid seal between the shell and the piston.

—EDITOR.

A WATERLESS piston-type gasholder, the first of its design to be erected in the United States and featuring a cylindrical cross-section and a mechanical packing-ring seal, was placed in service by the Syracuse Lighting Co., Syracuse, N. Y., on Feb. 24. Its capacity of 6,000,000 cu.ft. makes it the largest of its type yet built. Introduced in Germany about 1927 by August Klönne, some 45 holders of this design with an aggregate capacity of about 50,000,000 cu.ft. have been built in that country and elsewhere in Europe and Africa. The Stacey Brothers Gas Construction Co., Cincinnati, Ohio, has acquired the exclusive rights to the design in this country. In addition to the 6,000,000-cu.ft. Syracuse holder built by the Stacey Brothers company, it has also under construction a 4,000,000-cu.ft. holder for the Consumers Gas Co., of Reading, Pa., and a 1,500,000-cu.ft. holder for the Consumers Power Co., of Kalamazoo, Mich. The largest holder of this type abroad, at LaVillette, France, has a capacity of 3,531,000 cu.ft.

The Stacey-Klönne holder differs from the other piston-type waterless gasholders in use in this country principally in that the seal employed between the piston and the tank is mechanical rather than liquid and the cross-section is a circle rather than a polygon. A mechanical seal is claimed to be especially economical, since it eliminates the necessity for equipment required to pump and heat the liquid in liquid-seal holders as well as the maintenance cost of this equipment. The circular section of the tank eliminates corners that are said to be difficult to seal effectively, permits the piston to turn or twist without binding or disturbing the seal and gives unrestricted freedom to the operation of the rollers that guide the piston up and down the shell of the tank.

The tank of the Syracuse holder is 188 ft. in diameter, 251 ft. high to the top of the shell and is covered with a spherical roof surmounted by a 20-ft. diameter dome at the center to permit access to the interior, making the total height of the structure 290 ft. above the foundation. Within the holder is the structural-steel piston, to the perimeter of which is attached a flexible seal ring that confines the gas to the space below. When the piston is at rest on the land-



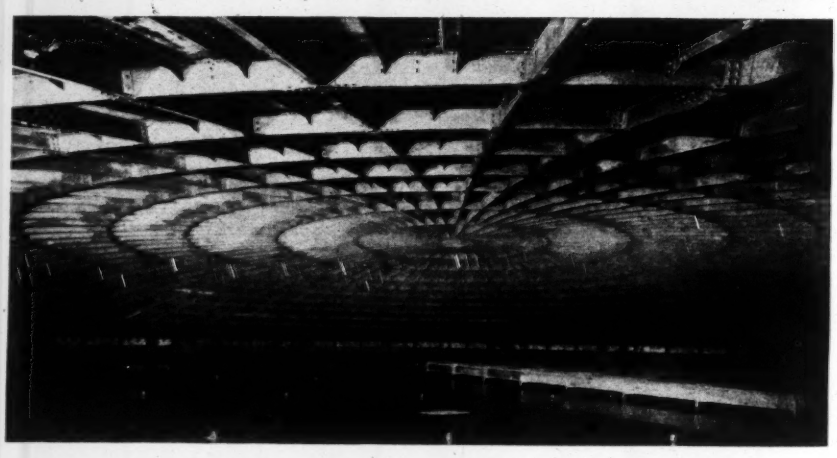


Fig. 1—Within the 188-ft. diameter shell of the Syracuse holder the gas is confined beneath a 500-ton piston designed as a self-supporting arch that imparts pressure to the gas. In the upper view, showing the top of the piston, may be seen the bracing with circular walkway girder at top that holds the wood rollers against the shell. The lower view, taken beneath the piston, shows its radial rib construction and at the right the pipe through which gas enters the holder.

ing blocks, its entire weight is supported at the perimeter, thus eliminating the necessity for providing a foundation for the interior area of the holder other than to support the bottom plating and gas pressure. The use of comparatively light foundations is one of the inherent advantages of all waterless gasholders over the older telescoping type with its heavy water load.

The steel materials in the Syracuse piston weigh about 500 tons and exert a 6-in. water column of gas pressure. However, the piston is designed to carry 500 tons of concrete blocks, so that the pressure may be increased to 12 in. if desired.

The shell of the holder consists of $\frac{3}{8}$-in. steel plates reinforced by 36 vertical 9-in. I-beams spaced 16½ ft. apart along the circumference and by 5x3½x $\frac{3}{8}$-in. horizontal angle rings spaced about 5 ft. apart vertically. In addition, there are seven 4-ft.-wide horizontal girders, or balconies, about 36 ft. apart. The shell plates are butted at the columns and riveted to them and to the circular angle stiffeners, with all rivets countersunk and ground smooth on the interior.

The piston is a segment of a sphere designed as a self-supporting arch made up of radial and circular channels except at the outer circumference, where a ring of 24-in. 93-lb. sections reinforced with a $\frac{3}{4}$x21-in. plate riveted to the web is utilized to resist the high stresses. This structural-steel frame is covered with $\frac{3}{8}$-in. plates riveted to all radial and circular channels.

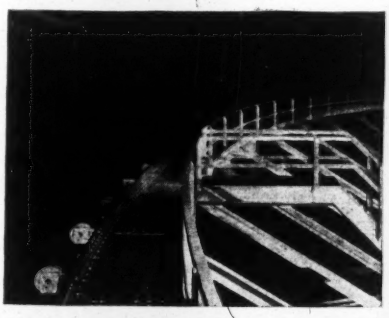


Fig. 3—Upper rollers with walkway girder and bracing that hold them firmly against tank shell as piston moves up and down. Rollers are of laminated wood.

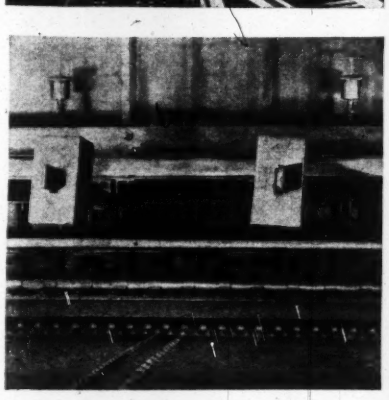


Fig. 4—Seal mechanism as seen from top of piston. Concave curved surface near bottom is flexible canvas-covered lead joint connecting piston to packing ring. Grease cups supply lubricant to tank shell to aid sliding of packing ring.

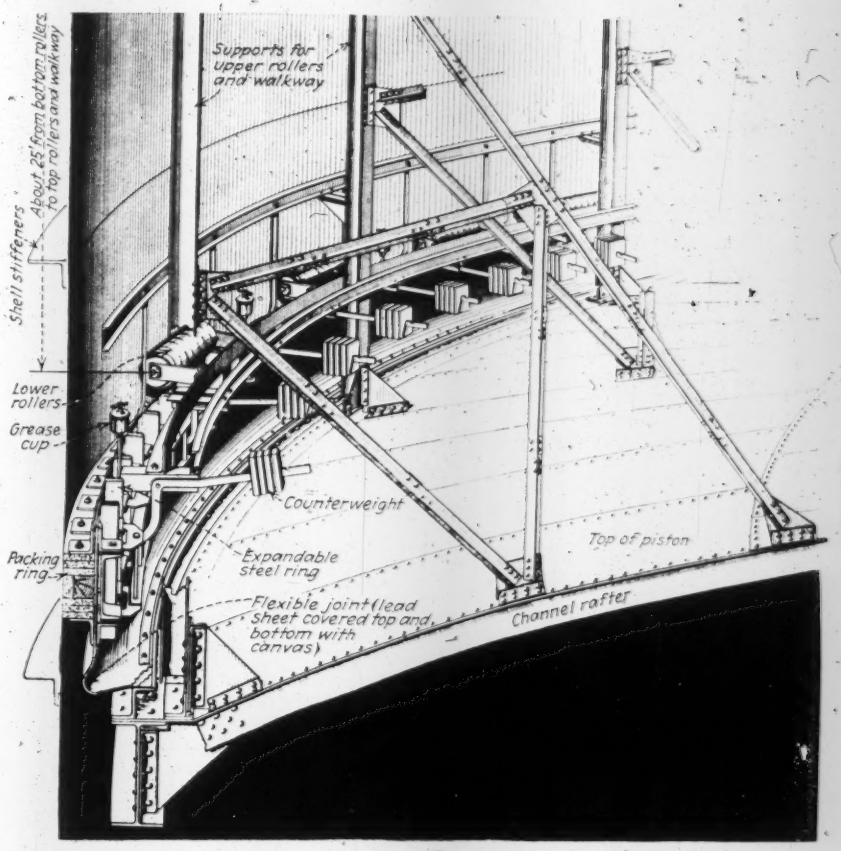


Fig. 5—Mechanical sealing of the annular space between the piston and shell is a major feature of the Syracuse holder. As shown, the seal is effected by pressing a packing ring attached to the piston against the tank shell by means of counterweighted levers. All parts of the seal are above the piston and thus easily accessible.

The piston is guided in its travel up and down the shell of the tank by an upper and lower set of laminated wood rollers 9½ in. in diameter, 18 in. long and spaced about 4 ft. on centers. Both sets of rollers, which are about 25 ft. apart vertically, are located above the piston and are accessible at all times. The lower set of rollers is located immediately above the piston or packing ring, the upper set being attached to the horizontal girder at the top of the structural bracing, which extends from the piston deck. This girder also serves as a balcony or walk when lubricating the bearings of the rollers.

The seal is made gas-tight against the shell by an expansible sheet-steel ring, to which is attached a packing made up of seven layers of cotton fabric vulcanized with a gas-resisting compound and faced with leather on the lower side where it is in contact with gas. This packing ring is pressed tightly against the interior of the holder shell by counterweighted lever bars. The lower edge of the continuous expansible steel ring is connected to the outer edge of the piston structure by means of corrugated sheet lead covered with fabric. This serves as a flexible joint between the piston and the packing ring and permits the ring to expand and contract as the holder shell expands or contracts from temperature or wind pressure. The shell of the holder is lubricated from grease cups on the packing ring with a special grease so as to reduce the frictional resistance. This lubricant is practically inert and remains static over a wide temperature range, so that it can be used the year round without heat or other special treatment.

The exterior of the Syracuse holder is provided with a stair and an electric elevator. Access to the piston is provided by means of an electrically operated lift suspended from the dome in the center of the roof and also by a double-chain folding ladder.

This piston-type holder is the invention of F. Schurmann, engineer of the firm of August Klönne, Dortmund, Germany. The Stacey Gas Construction Co., Cincinnati, Ohio, as the owner of the American patent rights, has designed and built the three holders constructed in this country to date.

Steel Pile Bulkhead Wall Retains Deep-Water Fill

Use of long steel sheetpiles for deep open-lake seawall is unusual and new—Seven million-cu.yd. fill adds 365 acres to Lincoln Park, Chicago

THE TASK of taking half a square mile of the waters of Lake Michigan extending to depths of more than 23 ft. for an enlargement of Lincoln Park in Chicago commands notice even among the extraordinary construction operations undertaken in the last decade to improve the city's vast inner ring of public parks. This most recent work, described in the following article, is notable in three particulars: first, for a dredge fill of seven million yards rising from lake bottom to heights of 8 to 22 ft. above lake surface; second, for the retention of some thousands of feet of the shore line of this fill by walls of sheetpiling; and third, for the shore-line design of the fill to make use of the currents in creating beaches outside the bulkhead walls. This use of sheetpiling is the outstanding construction novelty of recent Great Lakes harbor engineering.

—EDITOR.

ADDITION of 365 acres to Lincoln Park, Chicago, by pumping in some 7,000,000 cu.yd. of sand along the waterfront by means of hopper dredges is now in progress. Later a similar fill of 200 acres is to be made, including a 31-acre island about 1,000 ft. from the original shoreline. The present fill extends the park north from Montrose Ave. to Foster Ave., a distance of 6,000 ft., while the second stage will continue it about 8,000 ft. to Devon Ave.

An irregular shoreline is laid out, for landscaping purposes as well as to form a boat harbor and lagoon (Fig. 2). While its shape is outlined by permanent bulkheads, a special feature is that this shape is so arranged as to cause beaches to form at certain points outside of these bulkheads by intercepting the shore current and thus causing the deposit of sand. This natural fill supplements the sand pumped into place.

In the general view showing part of the work (Fig. 3), with bulkheads in place and the pipe lines for distributing the sand, sand beach is being formed inside the hook-end bulkhead at the left, both by natural accretion and by sand pumped into place. Three piers at the left are for the sand boats, one of which is in position. Below them is the old Lawrence Ave. intake crib of the Chicago waterworks, now abandoned and to be used as a park building.

From the shoreline of the existing park, about 5,000 ft. out from the end of Montrose Ave., the new bulkhead extends north for 1,800 ft. on a curve of 2,000-ft. radius, ending in a 150-ft. curve that forms a sharp hook to intercept the shore current. Another bulkhead curves shoreward on a radius of about 4,200 ft. until opposite Margate Terrace, and then it practically parallels the old shoreline north at a distance of about 1,500 ft. This ends at Foster Ave., where the bulkhead is turned east to the shore, marking the north end of the fill.

Steel pile and rock bulkhead

Steel-sheetpile bulkhead construction was used here for the first time in the open lake, and although it is in deep water and subject to violent wave action, it has proved quite successful. For the first 2,000 ft. of the bulkhead, extending north from a point opposite Wilson Ave., and for the curved bulkhead that retains the bathing beach the work consisted of two lines of arch-web interlocking steel sheetpiling driven to an elevation of 4 ft. above mean lake level. Each line of sheeting has an inside and an outside 8x12-in. oak waler with through-bolts at 16-in. intervals. At every fourth pile, or at 64-in. spacing, a wrought-iron tierod extends across the bulkhead, its ends passing through both the outer and inner waler. To stiffen the long lines of steel sheeting, transverse or partition bulkheads of close-spaced untreated oak piles were driven at intervals of about

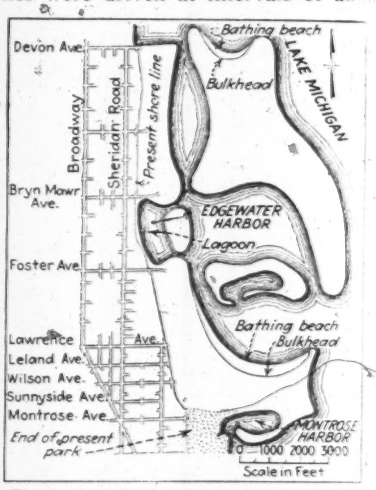


Fig. 2—Lincoln Park extended by filling in 10 to 25 ft. of water, forming new harbors and bathing beaches.

100 ft. For the above-mentioned part of the work the width between the two lines of steel sheeting varies from 20 ft. in water 20 to 23 ft. deep to 14 ft. in water 10 to 12 ft. deep. Piles 40 ft. long were used in the shallower parts and 42 ft. in the deeper parts.

Special steel waling

For the bulkhead extending north from Margate Terrace and returning to the shore at Foster Ave., a revised type of construction was used. Here each of the interior wales consists of a

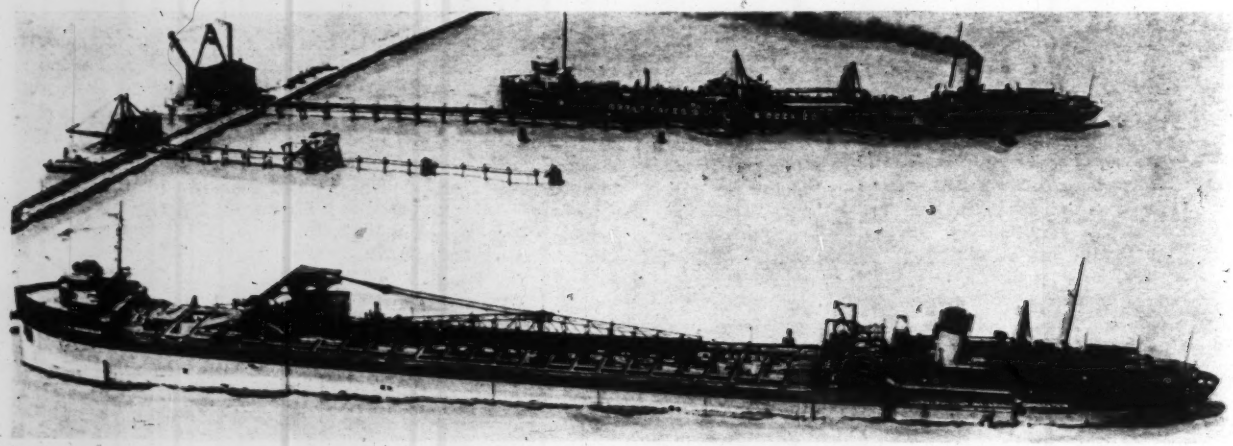


Fig. 1—Hopper dredges pumping sand for Chicago park. The "J. R. Sensibar," in foreground, has 6,000-yd. hopper capacity.

Chicago Aerial Survey Co. Photo

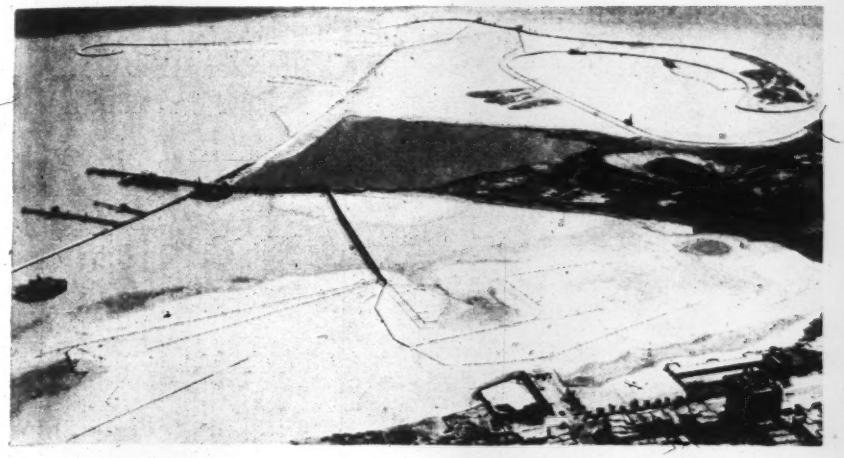


Fig. 3—Filling site for park, showing boat harbor at right, hook-end bulkhead and three piers for "sand boats" at left, with trestles carrying discharge-pipe lines. In left lower corner is the abandoned Lawrence Ave. waterworks intake crib.

Chicago Aerial Survey Photo

pair of 8-in. steel channels laid flat, back to back, but far enough apart to admit the ends of the transverse tie-rods. On the lake side an outer bumper timber, or wale, is bolted to the webs of alternate piles, but it is not attached in any way to the inside wale. No outer wale is used on the land side. Another difference is that the transverse partitions are only 75 ft. apart, and instead of wood piles they are composed of steel sheetpiling connected to the bulkhead sheeting by T-sections of the interlocking piles (Fig. 4).

The reason for changing from timber to steel wales was to eliminate any structural wale on the lake side, where it is subject to damage through heavy wave action and through the collisions of floating debris or boats. In the case of a failure of this wale the pier would be damaged. By placing the steel wales on the inside of the pier and bolting the tierods through them, this timber is eliminated. The outer oak wale in the new design is purely a buffer timber, and its loss or damage will not detract from the strength of the structure.

At the north end of the work, at Foster Ave., the bulkhead extending east from the short line for about 400 ft. consists of a single line of steel sheeting, for reasons of economy, as this part is not subject to violent wave action. The sheeting is braced by three untreated oak piles spaced 4 ft. c. to c. One line is on the lake side, and two lines are on the land side of the sheeting, which is bolted to these wood piles. Eventually this part of the bulkhead will form the foundation of a concrete retaining wall.

Placing the Rockfill — Quarry-run stone is filled into the bulkhead by derrick boats with grab buckets. After this has been leveled by hand it is covered by large blocks or capstones placed by the derricks, the finished surface being about 4 in. above the steel sheeting. A section of the completed bulkhead is shown in Fig. 6. On the lake side a revetment of quarry stones of 100 to 2,000 lb. weight is deposited to a height of 8 ft. above the lake bed. As a result of the tight lines of sheeting and their deep penetration, the inclosed sand and clay of the lake bottom cannot escape or wash out, and there has been no settlement of the stonefill sufficient to require additional fill.

Single-line steel bulkhead

For the 4,465 ft. of bulkhead along the inner line of the boat harbor, opposite Montrose Ave., a single line of sheeting was adopted, as there is little wave action. It consists of a row of 40-ft. steel interlocking piles with a pair of steel channels for waling on the land side and an 8x12-in. oak wale or bumper timber on the water side. Tierods 40 ft. long, at intervals of 5 ft. 4 in., extend from the inner steel wale to a line of anchor timbers placed behind a row of 45-ft. untreated piles. This construction is shown in Fig. 5.

To make the required curved outline of this bulkhead, guide piles were driven on the prescribed line and connected by 12x12-in. timber wales. These guide piles were located by transit. The floating piledrivers then placed the steel sheetpiles against this wale as a guide and drove them with steam hammers.

As this work was all done in the open water, it was necessary to secure the anchor piles and anchor timber firmly before any filling was placed against the steel sheeting. This was done by placing clean lake sand immediately around the anchor piles and anchor timbers. The sand was pumped ashore through pipe lines, the slacks in the joints bleeding the flow so that the sand would be deposited directly along the anchorage. After this anchorage had been secured, the remainder of the distance between the anchor logs and the steel sheeting was filled with sand in a similar manner.

Sand was specified for this fill in order to give immediate stability to the anchorage, since clay or earth would exert considerable pressure until getting to a final bearing, which might not be for some months.

Filling 7,000,000 cubic yards

After the harbor bulkhead had been completed, a small electric hydraulic dredge was used in dredging the harbor to a depth of about 20 ft. It received its energy through a submarine power cable laid to a substation connected with the local utility lines.

For the main body of filling it was important to have as little settlement as possible, so that the roadways, beach houses and other structures could be built and the landscaping carried out without delay, in order to make the park extension available to the public. For this reason it was decided to use clean

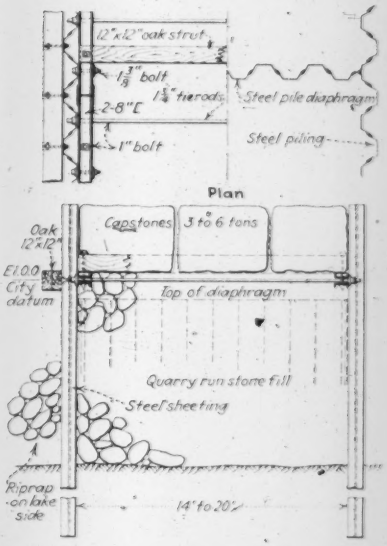


Fig. 4—Steel pile and rockfill bulkhead for deep-water end of filled area.

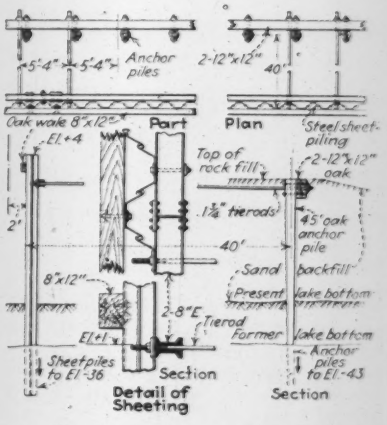


Fig. 5—Single line of steel sheeting anchored to wood piles forms bulkhead for boat harbor.

lake sand, hydraulically placed in accordance with finished topographic contours. Within this area the water averaged 16 ft. deep, and the fill varied from 8 to 22 ft. above water. At the south end, however, adjacent to the existing park land, some filling was done with rubbish and earth placed by dump trucks and leveled by tractors with bulldozers. Some mud and clay were also placed by a small hydraulic dredge.

Under a contract for 7,000,000 cu.yd. of sandfill, work was begun in May, 1931, and more than half the amount had been placed by the end of the year, the work being about a month ahead of schedule. For this filling the contractor and subcontractors had seven seagoing hopper dredges or sand boats with carrying capacities of 1,200 to 6,000 cu.yd. They dredged their loads in the lake off Indiana Harbor, 25 miles south of Chicago, conveyed it to the site and pumped it ashore, the ship's discharge

Fig. 6—Massive capstones cover rockfill of bulkhead. Sand will be filled in on at right side.

pipes being connected to long lines of piping carried on trestles. These distributing lines, which are indicated in Fig. 3, aggregated about 8 miles of 18- to 36-in. pipe. For bathing beaches the sand surface was given a slope of 1 per cent.

To provide for this method of filling, it was necessary to build piers and trestles for mooring the boats and supporting the pipe lines, as shown in Fig. 1. Channels had also to be dredged, 100 to 150 ft. wide, with 22 to 25 ft. of water, from the piers to deep water in the lake. The largest of these vessels is the "J. R. Sensibar," owned by the general contractor, which is a single-screw steamer with turbo-electric drive giving a speed of 14½ m.p.h. It has hopper capacity for 6,000 cu.yd. of sand and can discharge this cargo in a little more than three hours. On Oct. 23, 1931, it discharged this amount at an average rate of 4,035 tons per hour, pumped to a distance of nearly 1 mile from the ship. This vessel is shown in the foreground in Fig. 1.

Payment for the fill is made on place measurement based on soundings taken in advance and on soundings and cross-

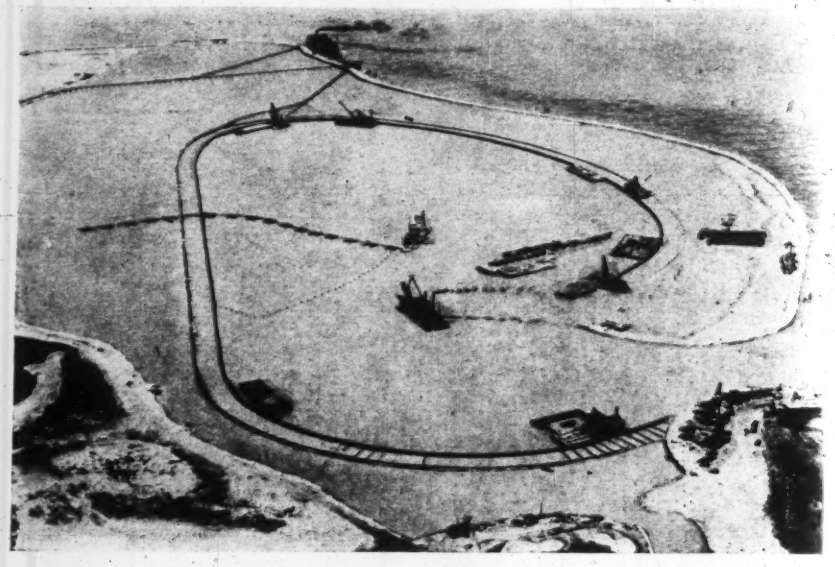


Fig. 7—Dredging and filling for boat harbor. Electric dredge and dipper dredge in harbor area. Hopper dredge in lake is pumping sand ashore through pipe line. Area in foreground, at right and inside hook-shaped arm, will be filled by pumping.

Chicago Aerial Survey Photo

sections taken of the finished fill. The cost averages 44c. per cubic yard, which includes the construction of piers and pipe lines by the contractor. Rough weather delays progress at times, but the seven boats placed 813,000 cu.yd. in September, and six placed 766,000 cu.yd. in October (average rate per day was 28,000 and 25,000 cu.yd. respectively).

While the bathing beach at Wilson Ave. is formed mainly by pumping sand on the outside as well as the inside of the bulkhead, a considerable amount of fill has been deposited by the shore current, which is here intercepted purposely by the curved and hook-end bulkhead. The outline of the bulkhead was determined after a study of the currents; its effect is to change direct southward flow to a slow spiral movement, which causes deposit of the sand.

Engineers and contractors

This park extension was planned and executed under the direction of Hugh E. Young, consulting engineer for the Lincoln Park Commission; E. H. Haug is in charge of design, and W. K. Cook is in charge of construction.

For the lakefront bulkhead the contractor is the Great Lakes Dredge & Dock Co., while the FitzSimons & Connell Dredge & Dock Co. had the contract for both the single-line bulkhead and the dredging and sand filling at the boat harbor. A general contract for filling the new park area was awarded to the Construction Materials Corp., which operates three suction hopper dredges and has let subcontracts to the Great Lakes Dredge & Dock Co., the Central Dredging Co. and the FitzSimons & Connell Dredge & Dock Co., which together operate four boats.

The work was carried on until Jan. 1, 1932, except in cases of heavy weather, and it is estimated that the sand fill will be finished in June, 1932. The cost of the above work is about $4,000,000, while the total cost of the completed park improvement will be about $8,000,000, including the main outer drive, local roads, landscaping and other work.

Vibration Sensation Analyzed

PHYSIOLOGIC TESTS last year of the effect of vibrations on human beings, by H. Reiher and F. J. Meister at Stuttgart, Germany, showed that the effect is measured by the product of amplitude and frequency and not, as has often been assumed, by the maximum acceleration, which is proportional to the product of amplitude and square of frequency. The results are reported in the *Zeitschrift des Vereines Deutscher Ingenieure*, of Dec. 19, 1931, p. 1,526.

Persons of different ages and susceptibilities were placed either prone or standing on a shaking platform, moved horizontally or vertically in harmonic motion with frequencies ranging from 3 to 70 cycles per second and amplitude ranging from 0.0001 to 1 cm. Their perception of the vibrations was recorded in six degrees: (1) no perception, (2) slight, (3) moderate, (4) strong and slightly annoying, (5) objectionable, (6) decidedly objectionable. Observations plotted on logarithmic frequency-amplitude coordinates arranged themselves in belts separated by straight lines of constant product frequency times amplitude.

It also developed that vertical vibrations are most strongly felt when standing. In prone position transverse horizontal vibrations are felt more strongly than those longitudinal to the body.

New York Subway Construction—VII

Contracts and Specifications

Uniform system in handling contract documents developed in thirty years of experience in subway construction

By James H. Griffin
Engineer-in-Charge, Division of Contracts and Specifications, New York Board of Transportation

SINCE 1900 New York has built, including lines now under construction, 271 route-miles, involving 835 track-miles, of subways at a cost of more than one billion dollars. In the development of this vast construction program there has evolved a uniform and definite system of contracts and specifications. Although the subway structure involves construction of unusual complexity, years of experience have brought the preparation and handling of contracts to a highly efficient state. As the preparation and control of contracts and specifications ranks in importance with the design and construction of the subways, the following article is included in this current series on New York subway construction. Previous articles in the series have been published Aug. 7, 1930, p. 200; Sept. 4, 1930, p. 371; Sept. 18, 1930, p. 455; Nov. 20, 1930, p. 796; Jan. 26, 1931, p. 136; and Dec. 24, 1931, p. 1000. —EDITOR.

THE RAPID-TRANSIT project in New York City has steadily grown since its inception in 1900 until, in recent years, it has reached enormous proportions. During the year 1930 the board of transportation awarded 102 contracts, including subway sections, station finish, installation of track, track materials, signals, electrical equipment, rectifier stations, substations, telephones, yard equipment, borings and miscellaneous work amounting to more than $87,000,000. The subway sections covered 12.22 miles of route and 43.18 miles of track. During the same period all work was completed and accepted on 74 contracts aggregating approximately $54,000,000.

Contract sections

For convenience in preparing plans and supervising the work in the field, construction is divided into sections generally about ½ to ¾ mile long. These sections, about the right size for the average contractor to finance, usually cost from $4,000,000 to $7,000,000 each, exclusive of track, equipment and architectural treatment.

The largest single contract let to date was for the construction of the Fulton St. tunnels under the East River, including approaches. Seven bidders submitted proposals for this contract, the lowest being $22,246,596. In this case separate bids were also invited for the construction of the easterly and westerly portions, but the lowest bid for the whole work was lower than the sum of the lowest separate bids. Many contractors are equipped to finance and execute more than one section simultaneously. Occasionally bids are invited for two adjacent sections separately and in combination under one contract, with the result that in nearly every case the combined bid is lower than the sum of the two separate bids. The letting of contracts by single sections is, however, the rule, in order that competition may be as wide as possible.

The installation of tracks, architectural finish and equipment is done under separate contracts because of the special nature of this work. An attempt is made to synchronize letting of contracts for construction, track, equipment and finish in order that all of these various features may be completed ready for operation at nearly the same time.

In 1930 the average number of bidders on section contracts was nine, the greatest number bidding on any one section being fourteen; which is indicative of the keenness of competition in this specialized field. The average section contract runs for a period of about three years. Not only are major changes in labor, material conditions and markets apt to take place in such a period, but the risks involved in underground construction in city streets are unusually heavy.

These factors, among others, have compelled the board of transportation and its predecessors to insist particularly that its contractors, before being awarded a contract, prove that they have the skill and experience and the ample financial resources to finance and execute the work fully. They must show that they will be able to carry on the work out of liquid assets, if necessary, during at least the first three months of the contract period. The wisdom of insisting upon these requirements is indicated by the fact that in all the history of subway construction, covering a period of 30 years and involving more than 300 major construction contracts ranging in price from $1,000,000 to $22,000,000 each, the city has declared only seven contractors in default in the performance of their contracts. At least two of such defaults were due directly to conditions brought about by the World War.

Contract documents

The contract documents consist of the *Invitation to Contractors*, the *Information for Contractors*, the *Form of Contractor's Proposal*, the *Form of Contract*, the *Form of Bond*, the *Special Specifications* and the *Contract Drawings*, together with the *General Contract Provisions and Standard Specifications*. These documents constitute the complete contract when properly executed by the parties and sureties and then delivered. The documents are bound under one cover, with the exception of the *Contract Drawings*, which, because of their number, are lithographed and bound under separate cover. For office use the *General Contract Provisions* and *Standard Specifications* are separately bound. In addition, the specifications for the various materials of construction are each separately printed and bound.

Four years ago the board of transportation issued a document containing general contract provisions and standard specifications covering what is generally known as legal provisions, including such matters as liability, security, payment, default, labor law and other general subjects; combining these with the part of the specifications common to this type of underground construction. This document is printed in quantity and held ready for binding with the other contract documents. Provision is made for making changes in the *General Contract Provisions and Standard Specifications* by amendment.

Preparation

The specifications are advanced as rapidly as possible during the period of preparation of the contract drawings. Field surveys are made, and drawings showing the location of existing surface, subsurface and overhead structures are prepared. The outside lines of the proposed railroad structure are then indicated on these drawings, so that data concerning interference with existing structures in the streets may be assembled.

The preparation of field information for use in contract documents involves much preliminary work, such as the running of base lines and levels, the securing of detailed surveys where private property is acquired, the location of buildings and building vaults and all such physical features as curbs, car tracks, elevated railroad columns, lamp posts, hydrants and manhole covers on the surface of streets. Subsurface structures such as sewers, pipes, conduits, tubes and ducts are located from surface indications and from such other information, sometimes meager, as may be secured from the owners of such subsurface structures. Types of pavement and curbs, the condition of buildings and pavements are recorded. Information as to character of excavation, water levels and other subsurface information is obtained from borings or secured from old maps and from other sources.

Such information and all other supplementary information obtainable is assembled and made available for the use of bidders.

The computation of items and quantities to be included in the contractor's proposal proceeds simultaneously with the preparation of the contract drawings, so that by the time the drawings are ready for signature by the chief engineer the contract is generally ready to be sent to the printer for page-proof copies. These page-proof copies, when received, are sent for comments to the designing engineers, to the field engineers who are to supervise the work, to the law department of the board and to the chief engineer. A date is fixed for the return of comments, and on that date a conference is usually held for the purpose of discussing any suggested changes. The contract therefore has the benefit of the knowledge and judgment of those in charge of the various phases of the work. While the drawings are being lithographed the contract and specifications are being shaped up, and about three weeks after printing the page-proof the contract documents are ready for sale to prospective bidders.

Unit-price contracts

The unit-price form of contract has proved to be the most suitable form of contract for subway construction. The character and scope of the work below ground cannot be accurately forecast. It is frequently found necessary to modify the construction shown on the contract drawings after the ground is opened. Bidders are therefore furnished with contract drawings that are in sufficient detail only to enable a unit-price bid to be prepared, and the quantities given for the various items are approximate and only for the purpose of comparing bids on a uniform basis. Although the unit-price form of contract has been found to have the decided advantage of necessary flexibility, bidders are tempted to assign disproportionate shares of overhead and profit to items that are paid for early in the construction period. There is a further temptation to load items that are likely to increase. Unbalancing of prices is undesirable, because it creates difficulty in making a fair part estimate and is apt to result in hardship for one of the parties to the contract in case of annulment. Contractors themselves are apt to be the worst sufferers, because work may be omitted under the item that has been unduly loaded. For these reasons the board of transportation reserves the right to reject any bid in which the prices are improperly balanced.

It is necessary under all contracts to perform certain work which, because of its nature, is not susceptible of classification under bid items and must be paid for by force account. For example, the removal and redrawing of power and telephone cables is highly specialized work that cannot readily be performed by the general contractor. Because of its importance the utility companies are permitted to perform the cable work with their own forces. They are paid through the city's contractor, who is allowed to add 5 per cent to the utility company's bill to cover his own administration and overhead expense. By a working agreement with the utility companies the city contractor is billed for the actual cost of materials and labor up to and including foremen, to which is added 15 per cent to cover the cost of plant, superintendence, administration and overhead expense. In the requisition for funds to cover the cost of work under the contract the estimated cost of such force-account work is added to the accepted bid price.

In ordering bids on the unit-price basis the city reserves the right to alter or omit parts of the work shown on the contract drawings and to compensate the contractor for constructing the work under the altered plans upon the basis of the unit prices submitted in his bid.

General contract provisions

The security required may be either in the form of bond with two or more approved sureties or an equal amount of cash or securities deposited in lieu of the bond. The amount of bond or cash deposit is generally fixed at about 10 per cent of the estimated cost of the contract. Bond premiums are based on the cost of the contract and vary in accordance with the proportion that the amount of bond bears to the total cost of the contract. One rate prevails for bonds between 8 and 12 per cent of the contract cost; another prevails for bonds between 12 and 18 per cent; and still another is used for bonds amounting to more than 18 per cent of the contract cost. The premium rate is on a yearly basis and is lower after the second year.

In addition to the general bond, a liability bond is sometimes required, as in the case of tunneling beneath an existing underground railroad. The liability bond runs directly to the owner or operator of the railroad, and is incorporated in the contract.

All contracts carry a provision for liquidated damages in the event of default or in the event of delay in the completion of the work. This is not a penalty which to be enforced must be accompanied by a bonus, but it is an amount agreed upon by the parties to be the estimated value of the loss suffered. The courts recognize this, providing only that the amount of the loss suffered shall be proved and that the sum written into the contract is not greater than the reasonable loss suffered.

The engineer is the arbiter of all matters affecting the contract and makes all determinations in relation to the work. Nevertheless, the contractor is not denied action by law. He is required to give notice of any claim against the city arising out of performance of his contract within ten da after sustaining the alleged damage, a he must file with the engineer itemized statement of the details a amount of the alleged damage. T contract provides that the acceptan of the final payment for the work sh operate as a release to the city fro all claim and liability to the contracto The provision for arbitration contain in early contracts was not continue and in the later contracts no specif provision has been made for arbitratio

Among the statutory provisions required to be inserted in all public contracts in New York State is the labor law that prohibits the contractor from employing men more than eight hour in any one calendar day, except in case of emergency, and provides that wage to be paid shall be not less than the prevailing rate for similar work in the locality where the work is performed. A recent amendment to the law requires that preference in employment be given to citizens of the State of New York. Persons other than citizens of the state may be employed when such citizens are not available. Contractors are required to keep card records of their employees, giving such information as may be required to insure compliance with the provisions of this amendment. Another recent amendment provides that each advertised contract to which the State of New York or a municipal corporation or commission is a party must stipulate that no laborer, workman or mechanic in the employ of a contractor be permitted or required to work more than five days in any one week except in cases of extraordinary emergency.

The rapid-transit act, as amended, under which the board of transportation and its predecessors are authorized to contract on behalf of the city, requires that the city give its contractor the right to construct the railroad "free of all right, claim or other interference, whether by injunction, suit for damages or otherwise, on the part of the owner, abutting owner, or other person."

The city therefore acquires all fees and easements in private property necessary for the construction of the railroad and assures its contractors the right to construct the railroad in the streets, including the right to destroy and occupy, where necessary, the numerous building vaults underneath the sidewalks. The permission granted by the city to owners of abutting property to contruct and occupy vaults under any part of the city streets may be terminated as soon as the space is needed for railroad or other street uses. The owner is therefore notified, when the contractor is ready to proceed, that the vault will be occupied and that the owner must remove his property immediately therefrom, in default of which the contractor is authorized to remove it at the owner's expense.

The rapid-transit act also conferred certain rights with respect to surface

COMPARISON OF STRESSES ALLOWED BY NEW YORK BUILDING CODE AND THOSE USED IN SUBWAY DESIGN BY BOARD OF TRANSPORTATION
(In Pounds Per Square Inch)

	Tension		Compression		Shear		Bond	
	Code	B. T.	Code	B. T.	Code	B. T.	Code	B. T.
Rolled Steel	18,000	20,000	18,000*	20,000*	13,500†	15,000†		
Cast steel	16,000	16,000	16,000	20,000				
Cast iron	3,000	4,000	16,000	20,000				
Concrete, plain	40	40	500	700				
Concrete, reinforced (extreme fiber)	.....	.....	650	850	40	70	100	100

*For columns, reduced for length.
†Rivets, power driven.

and subsurface structures, which read as follows:

Wherever or whenever the route selected . . . for the construction of such railroad shall intersect, cross or coincide with any railroad track or tracks occupying the surface of any streets or avenues, or the construction or operation of such railroad shall interfere with any pipes, sewers, subways or underground conduits or ways, any corporation or any contractor or person constructing any railroad or part of a railroad under any contract . . . is hereby authorized, for the purpose of constructing the said work, to remove the track or tracks of any such surface railroad or railroads, or any such pipes, sewers, subways or underground conduits or ways, but the same shall be done in such manner as to interfere as little as possible with the practical operation or workings of such surface railroad or railroads, or the works or business of the owners of any such pipes, sewers, subways, or underground conduits or ways, and upon the construction of such railroads built under and in conformity with the provisions of this act, where such removals or changes have been made, said track or tracks, pipes, sewers, subways, or underground conduits or ways shall be restored as nearly as may be to the condition in which they were previous to the construction of any such railroad built under the provisions of this act. . . .

The act further provides for the removal of any surface or subsurface structures beneath any street, park or public place, provided that such structures be replaced as soon as practicable either in the same position as before construction was begun or in another secure and convenient position.

Specifications

The specifications are the development of more than 30 years of experience in one of the world's greatest construction projects. Although they retain many of the principles of the early contracts, the specifications are a gradual development of experience coupled with changes in current practice. Some of the general principles upon which the specifications are based are as follows:

1. The work must be so planned and executed as to reduce to a minimum the interference with public travel. Facilities must be provided and maintained to permit uninterrupted access to abutting property and buildings.

2. All existing surface, subsurface and overhead structures encountered must be maintained in a safe condition for their usual service and to the reasonable satisfaction of the owners. All such structures and all surfaces affected must be restored upon completion of the work.

3. Questions left to the determination of the engineer are reduced to a minimum. Wherever privately owned structures or structures under the jurisdiction of other departments of the city are affected, advance approval is obtained from the owners or from the city departments, as the case may be, of the plans and methods affecting their structures. The approved plans and methods are given in the contract. Contractors are permitted to use their own plans and methods in lieu of the approved plans and methods given in the contract, provided such substituted plans and methods are approved by the engineer.

In general, tests prescribed for materials of construction are in accordance with standards of the American Society for Testing Materials. Although the work of the board of transportation is outside the jurisdiction of the New York building code, the requirements for buildings, substations and similar structures conform, in general, to the code. A comparison of some working stresses for steel and concrete used by the board with those prescribed by the code is given in an accompanying table.

The extreme fiber and direct-compression working stresses in concrete used by the board of transportation were recently raised from 600 to 850 lb. per sq.in. and from 500 to 700 lb. per sq.in., respectively, due to the fact that the present specifications and inspection are producing a higher strength concrete than formerly. The 1929 yearly average of tests on 1:2:4 concrete, inundated or weighed aggregates, with a maximum limit of 6.25 gal. of water per bag of cement, was 3,200 lb. per sq.in. at 28 days and 3,600 lb. per sq.in. at 90 days.

Extras

As has been stated, certain work not susceptible of classification under bid prices is paid for by force account. The force-account work specified will average about 2 per cent and may amount to as much as 5 per cent of the cost of the contract. In addition, there is unforeseen work, commonly known as "extra" work. The volume of unforeseen work on section contracts might reasonably be expected to be quite high, because the project involves construction mostly below ground and quite complex. On ten of the major contracts of the Washington Heights line in the borough of Manhattan, recently completed, the extras amounted on an average to 0.74 per cent of the final estimate, the highest being 1.4 per cent and the lowest 0.03 per cent. By the terms of the contract the extra work may be performed by force account, or the engineer may, subject to the approval of the board of transportation, agree with the contractor on a unit price or a lump-sum price to be paid for the work, provided the total amount thus agreed upon shall not exceed 2 per cent of the bid price of the contract. Where it is possible to estimate the cost of the extra work in advance of performance it is preferable to do the extra work under unit or lump-sum prices to be agreed upon. It is difficult to manage force-account work so as to secure economy.

Organization

The board of transportation of the city of New York has charge of the design and construction of subways. John H. Delaney is chairman of the board; Robert Ridgway is chief engineer; John R. Slattery is deputy chief engineer in charge of construction; A. I. Raisman is chief designing engineer; and H. N. Latey is chief electrical engineer. The organization is divided into the following seven divisions, with the division engineer of each named: design, C. E. Conover; division I (construction of lines in Manhattan below 57th St. and in Brooklyn), J. O. Shipman; division II (construction of lines in Manhattan north of 57th St. and in Queens and The Bronx), John H. Myers; tunnel division (all subaqueous tunnel construction, regardless of location), J. B. Snow; track, R. H. Jacobs; station finish, J. T. Kane; materials inspection, G. L. Lucas. In the field each section is in charge of a resident section engineer. Several sections are grouped under the direction of an assistant division engineer reporting to the division engineer. The writer is in charge of the division of contracts and specifications, under the chief designing engineer.

Single-Track Concrete Roads

During 1931 there were 43 counties in eleven states that constructed a total of 218.7 miles of single-track concrete road and widened 47.5 miles of single track previously constructed. Champaigne County, Ill., practically completed a 160-mile system of county roads of single track and is now planning an addition of 130 miles. A careful survey of single-track concrete roads in the United States shows that more than 3,000 miles has been built by 207 counties in 30 states. Their use extends from light-traffic state routes, as in Missouri, to main-traveled local roads, where their use is most common.

Tower-Excavator Development for Levee Building

Slackline-cableway excavators with traveling towers developed into major earth-moving equipment in constructing Mississippi River levees

By J. C. French
Bucyrus-Erie Co., South Milwaukee, Wis.

NEW PROBLEMS result ultimately in the development of methods of solving them. Shortly before the war an increase in levee section on the Mississippi River added to the then difficult task of transferring earth from wide shallow borrowpits into the levee at reasonable cost. The change stimulated thinking along the line of developing the slackline cableway, which in rather crude forms had shown efficiency on other earth-handling operations. The modern tower excavator is the result. It combines mobility and large capacity with ability to move earth in one operation from borrow to fill with a range of distance close to 1,000 ft. The tower excavator was developed primarily for levee building along the Mississippi River, but because of its application to the canal work at Beauharnois, Que., a knowledge of its possibilities will be of value to engineers generally. —EDITOR.

THE TOWER EXCAVATOR, or traveling slackline-cableway excavator, has been developed particularly for levee building. Compared with other earth-moving equipment successfully employed for levee construction, it is a special-purpose machine. This is true also, but in somewhat less measure, of the stationary-tower slackline-cableway excavator so highly developed for sand- and gravel-pit operations. In this article the traveling-tower slackline-cableway excavator is alone considered — specifically the type of excavator as developed for levee construction on the Mississippi River and known as the tower excavator.

Early experiments

The tower excavator was developed out of the necessity for a more economical method of constructing the larger Mississippi River Commission 1914-grade levee section. This section, with its 40-ft. sloping banquette, called for so much greater yardage and longer borrow haul that the prevailing levee building (largely mule-team) methods were no longer economical.

R. H. & G. A. McWilliams, contractors, Chicago, Ill., obtained a levee project near Waverly, Ark., to try out a tower excavator that was equipped with a scraper bucket that had been invented by O. G. Oglesby. The machine was then known as a tower-dragline excavator, and the pioneer unit was mostly of timber construction. This new levee-building machine consisted of two traveling towers, between which a bucket, controlled by a slackline cable, was dragged back and forth. The propelling power was a drag cable and a tail rope attached to a bridle fastened to the front and rear of the bucket, and both lines operated from the main tower. After many delays, due to the experimental features of the machine, contract work was finished.

About this same time Major John R. Slattery, Corps of Engineers, U.S.A., experimented with a taut-line-cableway tower excavator. This machine was designed by the Lidgerwood Manufacturing Co. along the lines of similar tower cableways that had been used for excavation in other locations. It was employed on levee enlargement during 1915 and also on several other projects at a later date.

The machine had two towers, tail and main, which were counterbalanced against the bucket load. The towers were placed so as to span the borrowpit, berm and levee section, and the bucket was carried on a trolley, mounted on a track cable. The bucket was loaded in the borrowpit, hoisted and carried to the levee fill, where it was emptied from a considerable height. The idea of the high dump or discharge was to pack the material into the levee fill. The bucket weight required tremendous counterbalancing weights on both tower units, which multiplied the traction difficulties. The cable wear was excessive and mechanical delays were frequent, so that the actual yardage placed in the levee was limited.

Another cableway excavator of the slack-line type was placed in commission on the river work during 1913. This excavator had been developed and used on the Chicago drainage canal and also on the New York State barge canal. It was termed a tower excavator in that its principal part was a movable tower. From 1912 to 1915 this machine had been greatly improved and adapted to earth movement and placement, and its trial on the levee work was a natural development. It was built under the Field patents by the Clyde Iron Works.

Constructive development

Constructive development of the tower excavator as a levee-building machine began with the acquisition of the Oglesby machine and its thorough mechanical redesign and construction by the engineers of the Bucyrus Co. Between 1918 and 1924 the Mississippi River Commission purchased a number of the improved machines, many of which have been in use ever since and are still doing effective work.

This group of machines had timber and, later, steel-frame towers mounted on trucks to travel on rails. The head towers ranged about 72 ft. high. Steam power was retained, but the power plant and all the operating machinery were redesigned to provide a coordinated mechanical unit. The buckets were the 5-yd. closed type. Various changes have been made in these machines during the ten or more years of their use, such as crawler traction, diesel-power units and heightened towers. With only such replacement and excellent upkeep these machines have established notable records of output and economical opera-

Tower excavators were used to advantage in the construction of the Birds Point-New Madrid floodway.

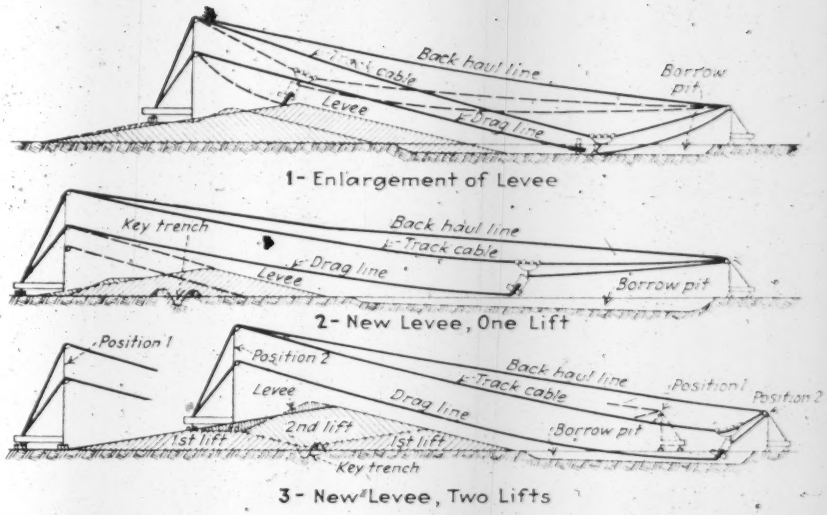
tion. The monthly yardages have been increased five- and six-fold by better operation. With revamped towers and equipment and by skillful two-trip operation, the 1918-type machines are building the 1928-grade levee, which is vastly larger than the 1914-grade section for which they were designed. In general, however, these old machines are obsolete equipment.

A new tower excavator has developed with the requirements of the new and larger levee section. This new machine is shown in general essentials by the accompanying illustrations. Visually the most striking change is the steel-mast head tower. In brief summary, however, the new designs have increased the speed of the haul-in and bucket return, raised the tower heights, increased the efficiency of the driving machinery and the traction units, and has substituted for steam the diesel, diesel-electric and electric-power units. The design features of these new elements are the manufacturers' problem, and only those particularly affecting operating ranges are considered.

The new tower heights of 136 and 50 ft. increase the span coverage of the machine to include all usual ranges of levee sections called for by the 1928-grade level and all normal widths of adjacent riverside borrowpits having 1 on 50 slopes from a 3-ft. cut beginning 40 ft. from the levee. The economical span is 750 ft., which can be worked without overwinding the ropes and with a 10-yd. bucket. Where borrowpit conditions make it necessary the span can be extended to 1,000 ft., but the effort should be not to exceed the 750-ft. span, and this is nearly always possible by two-trip construction.

A notable improvement is the cable speed control possible with electrical operation. In loading the bucket a slow speed is desirable, but in hauling the bucket to the levee the travel should be much faster. In the new machines the variation of speeds is provided by the variable voltage (Ward-Leonard) control of the driving motor and drum set. This control is automatic; as the resistance of the drag cable decreases the cable speed increases. Thus the speed of the drag cable will vary continuously from the time the bucket digs in until the load is deposited in the levee, the variation being directly proportional to the resistance.

Tail tower, carrying track and back-haul cables, travels parallel with head tower. It is about 50 ft. high.



Representative levee-building procedure with tower excavators.

In general the speed, span range, mobility and simplicity of power units and service are increased in the improved tower excavator. Power supply, in cases where it is not commercially available, has been satisfactorily worked out by diesel-electric-generating plants installed near the operation.

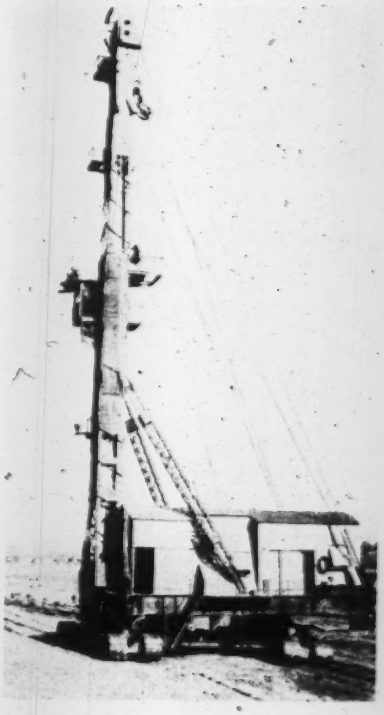
Operating procedure

In operation, the head tower is on the levee line, and the tail tower is across the borrowpit opposite the head tower; the excavating bucket travels back and forth between the towers on a track cable that connects them. Several operating positions are shown by the accompanying illustrations. An operator in the head tower controls the design from an elevated stand, from which he can see the entire bucket movement. A man in the tail tower shifts its position with respect to the head tower according to signals from the head-tower man.

In operation, the bucket is dragged in through the borrowpit by the drag cable, which on its way from the drum to the bucket passes over a sheave mounted in the head tower at about the height of the operator's position. During the digging operation the track cable upon which the bucket trolley runs and which leads from the top of the head tower to the top of the tail tower is slacked off by manipulation of the track-cable drum, which is part of the head-tower machinery. When the filled bucket has reached the point where it is to be dumped, the operator takes up the slack in the track cable, thereby lifting the rear end of the bucket and dumping its contents. This operation can be very definitely controlled and the material accurately spotted.

When the bucket must travel far in order to get its material, the tightening of the track cable may not produce a sufficiently steep angle of rope lead from the top of the head tower, to cause the bucket to run to the beginning of its digging stroke by gravity. In such cases a backhaul cable is used. This cable comes from its own drum on the head tower, leads over a sheave at the top of the head tower, passes over to the top of the tail tower and then leads to the back of the bucket. The bucket is therefore manipulated vertically by means of the track cable, it is drawn toward the head tower by the drag cable

Head tower of latest-type electrically operated tower excavator is 136 ft. high, giving machine long span coverage.



and pulled back into the pit by the backhaul cable.

Construction methods

Two methods of construction are employed—the single-trip method and the two-trip method. Both methods are indicated in the accompanying illustrations. In the two-trip method, instead of backtracking the machine for the second trip, two machines are sometimes used—one for each set of operations. For each machine the operating force averages about as follows:

One man is generally placed on the river-side slope of the levee for grading, and four or five men are required for the grading of the land-side slope. More men are required when sticky gumbo is being handled.

One spotter to direct the discharge of the bucket is usually placed upon the levee fill, and his aid to the one operator located on the tower insures proper placement of each load. One oiler or machine man is located inside the cab of the machine to take care of the machinery units. There is also a tail-tower operator.

If a track-type machine is used, three to five men are employed to handle the track sections. When self-contained runways for carrying and shifting the track sections are provided, with chain hoists for the lifting operation, two men with a tractor shift the track sections.

When caterpillar traction is used it is necessary in extremely wet weather to provide a corduroy path to eliminate traction difficulties. This corduroy path generally is made of planks, and five or six laborers are employed to move them gradually ahead into position for the machine travel. This corduroy track is sometimes necessary for the tail tower, especially during the high-water season, and extra labor is required for this purpose.

Small dragline machines are required to operate in conjunction with a tower excavator, to excavate the key trench or ditch, to grade off the old levee section to form a pathway for the head tower if the construction is enlargement of an old levee, and to perform emergency work during the wet seasons if slides occur and a material replacement is necessary that would not warrant the return of the tower excavator to complete.

Economic considerations

The cost of excavating, conveying and placing the material increases with the increase of the borrowpit depth and width, the conveying distance and the levee-section height. Eventually, therefore, an economic limit is reached in these distances beyond which the value of the material that is being excavated and placed will not permit any further increased cost.

Hauls that average 450 to 500 ft., including the borrowpit dimensions, the berm and the levee base width, are not considered tower-excavator projects. At considerably longer spans the tower excavator is more economical than any possible loose-motion, and longer-haul method. There is no abrupt break, however, in the cost curve at 500 ft.

The great advantage that features the tower excavator is its ability to secure the borrow materials from the farthest edge of a shallow borrowpit and to deposit the materials into the levee section in one operation.

No power is required for the bucket return on a short span, but for spans of more than 650 ft. a back-haul line should be used. This back-haul line retards the bucket-return speed slightly, and it is more economical to keep the span distance to the maximum gravity bucket-return requirement, if possible.

The bucket capacity of a tower excavator is limited to its yardage size during the wet levee-building season when the materials are wet and clinging. Operation in the regular or dry season allows the bucket to push ahead of itself from 4 to 6 extra yards.

Performance records

Under perfect operating conditions, with dry sandy loam materials, dry borrowpits, dry and firm ground conditions for traction movements, the tower excavator will handle as high as 250,000 cu.yd. per month, working two eleven-hour shifts per day. A general average of all machines that have been in operation upon the river work will approximate 150,000 to 200,000 cu.yd. per month during the so-called levee-building season, which is about seven months of the year.

Survey Indicates Doweled Pavement Joints of Doubtful Value

THE possibility that dowels, as they ordinarily are employed in pavement joint construction, are failing to accomplish what has been expected of them, is pointed out in the report of the committee on reinforced-concrete pavements and bases of the American Road Builders' Association. A careful survey by the committee showed that smooth dowel bars with capped ends, either half greased, painted or sleeved, are employed through transverse expansion joints in 26 of 39 states using such joints. The dowels used include ½-in. square, and ½-, ⅝- and ¾-in. round bars. The ¾-in. round bar is by far the most popular size, being the choice of 16 of 26 departments. The spacing of those dowels varies from 12 in. to 48 in. The 36-in. spacing is most used, followed by the 24-, 28- and 30-in. spacings, in the order named, the average of all spacings being 31 in. One state uses dowels only in slabs of short length, while two states dowel slab ends only over poor subgrade.

Transverse contraction joints are doweled or tied in nine of 20 designs using such joints. In six of these cases slip-dowels are installed similar to dowels through expansion joints. In one case bonded and one case bondless marginal bars are continued through the contraction joint. In one case fabric reinforcing is continued through the joint. The practice of omitting dowels at transverse contraction joints, from the standpoint of rational, well-balanced design, is quite open to question. Slab ends at such joints become free ends upon contraction and are therefore subject to high load stresses similar to slab edges. Likewise where contraction joints are installed to predetermine crack locations and to open under contraction, the practice of placing bonded steel across the crack is questionable.

The structural efficiency of slip-dowels as commonly designed at present is now being seriously questioned by many designers. At best the dowel is a rather dubious means of maintaining slab alignment and transference of load, particularly at expansion joints where comparatively wide openings occur. Play of the dowel in its bondless socket, coupled with the high intensity of bearing on the concrete adjacent to the joint edge, tends to permit movement which, together with a certain amount of bending in the dowel itself, results in a questionable efficiency with respect to the transference of an adequate proportion of load applied to one edge only. It is thus evident that if the dowel is to function with any degree of efficiency at least a comparatively close spacing is required and it is decidedly questionable whether the customary spacing of 3 ft. is sufficient to provide proper doweling action across an appreciable width of the slab. Certain tests have indicated that dowels as commonly designed are decidedly inefficient in transferring load, while theoretical analysis has shown that a spacing of at least 24 in. should not be exceeded.

At the present time dowels, therefore, constitute a feature of concrete pavement design which is receiving the serious attention of many designers. One state now using dowels reports the possibility of discontinuing their use entirely, while another state that has been using dowels on comparatively wide spacing has tentatively adopted a 10-in. spacing across the entire width of the slab. Other designers are approaching this feature of design from the standpoint of eliminating dowels entirely and providing additional strengthening of slab ends through the use of extra end-bars or extra end-sheets of reinforcement.

Two-Course Concreting Assures Exact Level of Steel

Recent devices for striking off paving slab at part depth eliminate disadvantages of older methods for fixing height of reinforcing mesh

THE LOCATION of paving-slab steel, true to level and plane, has become increasingly troublesome as slab output has increased. In the same period the demand for precision in locating reinforcement has become more exacting. To maintain the concreting speed established by modern practice, many operations must go on in the subgrade pit while the reinforcing steel and its supports are being placed. The placing method has therefore to be one that will least delay the other operations and that they will delay the least. A review of development that has finally led to the very old method of concreting the slab in two layers is given in the report of the committee on reinforced-concrete pavement of the American Road Builders' Association. The advantages of the method deserve careful consideration by roadbuilders.
—EDITOR.

VARIOUS METHODS have been devised for placing fabricated reinforcement in concrete pavement. The prevailing practice for several years was to use chairs or other supports on which the sheets of reinforcement were supported and the concrete poured through the reinforcement. This method proved satisfactory for slow-moving projects, and, when sufficient and adequate supporting units were used, good results were obtained. On projects where maximum mixer output was highly desirable the placing of chairs tended to delay paving speed.

There was then developed an overhead installing device consisting essentially of bars extending across and resting upon the forms. These bars had projecting hooks or fingers, which engaged and supported the reinforcement while the concrete was being poured. While this device had certain advantages, it had to be constantly picked up and moved ahead, involving considerable labor cost and interfering to some extent with the concrete shovel men and the finishing machine. Also there was a tendency for concrete to become incrusted on the bars and around the hooks so that handling and use became cumbersome. Unless fairly heavy reinforcement was being used, the necessary walking on the supported steel tended to bend it out of position.

Sled-installing device

The next advance was a sled-installing device that has been widely used. The sled is a series of parallel steel members from 1 to 4 ft. apart serving as runners, connected at one end by a steel cross-member. It is placed on the subgrade with the runners parallel to the road axis, and on the runners is placed the sheet or mat of reinforcement. The crossbar of the sled is attached to the mixer so that, when the latter moves ahead, the sled is withdrawn from the previously poured concrete, leaving the reinforcement in its proper position in the slab.

A number of objections to the use of the sled-type installing devices have been set forth: (1) The sled runners, on being pulled forward out of the concrete, tend to create planes of lamination within the concrete. (2) Since the sled advances with the mixer, there is no opportunity to correct minor subgrade irregularities after the mixer has passed over the subgrade. (3) Sprinkling of the subgrade must be through the sled; thus the soil under the runners is sheltered, inducing increased absorption of water from the concrete over the runners, with resulting cracks. (4) Since the reinforcement must be placed on the sled prior to pouring the first batch after a mixer move, both the reinforcement and the sled members interfere with the prompt and proper installation of center plate, tiebars, expansion-joint bulkheads, dowel bars and other usual incidental items. The sled, on being withdrawn, may foul tiebars or other accessory steel. (5) Especially in urban paving, the sled is constantly interfered with by manhole castings, valve boxes and other structures. (6) With the reinforcement supported by the sled runners, it is almost necessary that the laborers, spreading concrete and doing other work, walk on the steel, which, being supported only at intervals, tends to bend out of proper position.

Fig. 1—Installing fabricated reinforcement with a hand-pulled strike-off templet. As few as three men may operate this templet satisfactorily.

Strike-off methods

It has now become generally accepted that the strike-off method presents the most effective means of placing the reinforcing sheet or mat firmly and accurately in its proper position in the concrete slab. Since it is placed on an evenly surfaced bed of concrete, the necessary walking of the laborers does not bend or distort the reinforcement to any extent. Also, since the surface baches are placed immediately, there is no possibility of a lamination plane. By this method concrete is deposited on the subgrade and is roughly leveled by a strike-off board or templet to an elevation about 2 in. below the final concrete surface. The reinforcing sheet is placed on this bed of prestruck concrete and immediately covered with additional concrete, which is screeded and finished to the required pavement surface.

The basic advantage of the strike-off method is that it permits installation of the reinforcement just prior to a mixer move, whereas, with any method involving the use of an installing device, the reinforcement must be placed immediately after the mixer moves to a new position. In any paving project, whether reinforced or not, the period during which delay is most likely to be caused is the time just after the mixer has moved to a new position. By the strike-off method no work connected with the use of reinforcement is required to be done during this period. Rather, the reinforcement is placed during a normal mixing period when no additional operations are necessary and when ample time and labor are available for its installation. The strike-off method is the only means of installing reinforcement whereby the subgrade pit

is allowed to remain clear for the proper subgrade and preparation work in the pit, and for the immediate pouring of the first batch of concrete after the mixer moves.

Operating methods

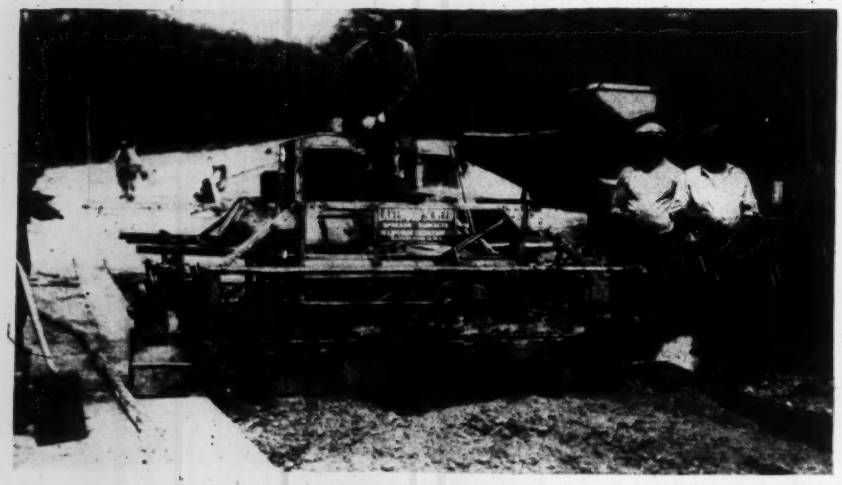
There are about four general methods of making the preliminary strike-off in the field. These may be grouped as follows:

Hand-Pulled Templet—While obviously requiring additional labor as compared to mechanical methods, this method (Fig. 1) has proved to be accurate and fast, especially where labor is cheap, or where a short job is to be placed, or where a finishing machine is not used.

Hinged Plate on Finishing Machine—This method (Fig. 2) involves the use of an auxiliary plate attached by means of hinges to the front screed board of the regular finishing machine. This plate is so hinged that, when let down, it strikes off the concrete at the required depth, usually 2 in. below final surface. In this way labor is eliminated and the strike-off work becomes purely a mechanical operation. This method is especially adaptable to pavements poured by the lane-at-a-time method, where the mixer operates outside the forms. Some delay may be occasioned when this method is used on a job where the mixer travels on the subgrade.

Templet Operated by Mixer Power—A most excellent method developed within the last few years employs power from the mixer to pull the strike-off templet ahead. Under this plan cables are attached near the ends of the strike-off templet and run to an auxiliary power shaft on the mixer. The control lever is usualy arranged so that either the mixer operator or a ground man can pull the templet ahead at will.

Fig. 2—Hinged plate mounted on the screed board, of the usual finishing machine strikes off the concrete 2 in. below final pavement surface. This method is especially adaptable to lane-at-a-time paving procedure, with the mixer operating outside the forms.



Where such an auxiliary shaft is available on the mixer or may be readily installed, this method of making the strike-off is adequate to meet all requirements and has been extensively used on numbers of high-speed jobs.

Cable-to-Finisher Method—Within the last year there has been developed a new method of operating the strike-off. This simple arrangement (Fig. 3) employs the power of the finishing machine and is so coordinated as to eliminate all delay and additional labor. Cables of about ⅜-in. size are attached to the end of the strike-off templet and run forward toward the mixer, through anchored pulleys and then back along the form line. The templet is then moved forward by attaching the cables to the finishing-machine framework (wherever the latter may happen to be) and backing the finishing machine away from the mixer. The pulleys may be anchored to the subgrade templet, to a projection from the mixer, or, if the mixer is outside the forms, to form pins or other anchorage. This method, developed in Missouri, has been tried out in a number of other states with general success on two-lane projects. While it is adaptable also to lane-at-a-time paving, it is doubtful that the finishing machine would be able to maintain maximum mixer speed. Excellent speed and minimum labor costs have been generally observed in this method on general highway work.

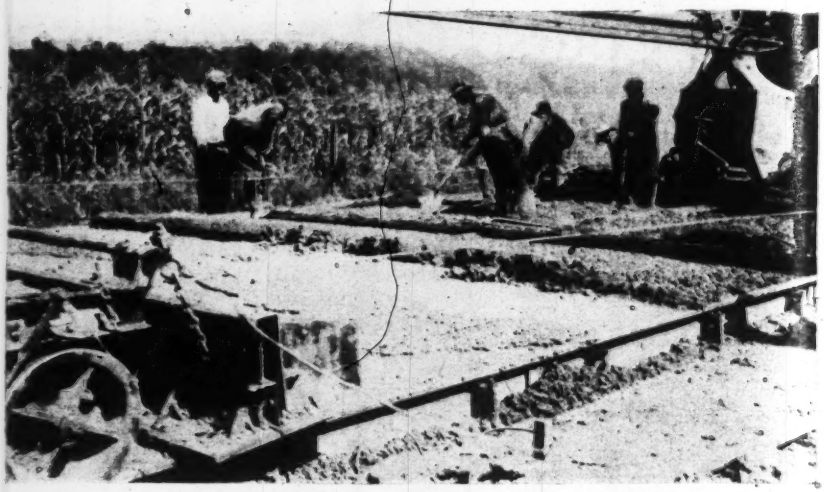


Fig. 3—Recently developed "cable-to-finisher" method of making strike-off. In the left foreground may be seen the finishing machine to which are attached wire cables. These cables run through sheave blocks suitably anchored to or near the mixer and extend back to the ends of the strike-off templet.

From the standpoint of installation cost it may be noted that the cost analysis of a recent highway project in Kentucky showed that the total job cost of hauling out and placing fabric reinforcement by the strike-off method amounted to less than 1c. per square yard, and that no delay in paving speed was caused as compared to similar plain pavement on the same project.

Louisiana Drainage Work Covers 3½ Million Acres

Organized land-drainage enterprises in Louisiana number 741 and cover 3,655,483 acres, according to figures of the 1930 census, with 2,486,972 acres sufficiently well drained to raise average crops. Their individual areas ranged from 500 to 50,000 acres. About 10 per cent of the land was in enterprises that were reported as in arrears of payment of principal or interest on bonds or other obligations. Drainage work serving 123,163 acres included 7,701 miles of ditch, 2 miles of tile, 575 miles of accessory levees and eighteen pumping plants aggregating 6,495 hp. and a capacity of 2,950,500 g.p.m. The capital investment of $20,752,645 averaged $5.68 per acre. About 37 per cent of the drained land was in enterprises that let contracts for maintenance. Operation and maintenance (in 1929) averaged 8c. per acre.

Lateral Clay-Pressure Phenomena in a Detroit Foundation

Goldbeck cells in caisson walls disclose eccentric and also unexpectedly great lateral pressures in constructing power-house foundations in Detroit clay

By J. R. James
Senior Engineer, Detroit Edison Co. Detroit, Mich.

THE CONSTRUCTION in 1927-28 of the first section of the Delray power station No. 3 of the Detroit Edison Co. was the earliest use in Detroit clay of open-well caissons sunk to rock. Some of the methods were described in *Engineering-News Record* Sept. 15, 1927, p. 421. Previous structures of the company had been supported on spread footings or lot-size mats. In the new work some of the subsidiary structures, such as the storehouse and transformer mats ((Fig. 1) and the piers for a coal-conveyor bridge, were also put on spread footings, with bearing loads ranging from 700 to 2,000 lb. a square foot. As previous spread footings had settled, settlement of the new structures was expected. The settlement proved more than anticipated and gave reason for a study of the clay action that is outlined here.

—EDITOR.

IT WAS NOTICED after construction that the three transformer mats of the Delray power house had settled approximately the same amount, a little more than 1½ in. on the average, but one mat had a soil pressure of 700 lb. and the other two a soil pressure of 1,100 lb. per sq.ft. due to the fact that one mat was unloaded, whereas the other two supported 50,000-kw. transformers. This was looked upon as evidence that the ground was experiencing a downward movement and that a question of soil-bearing capacity was not involved.

About eighteen months after the initial construction period had been completed, the rate of settlement of the warehouse and bridge piers exhibited a sudden increase, caused no doubt by the excavation at that time of the caissons for a fourth battery of boilers. This situation was taken care of by jacking the cylinders well in advance of the removal of the clay until the cylinder was sealed into the hardpan. The time element, which is important in this escape of clay into the shaft, was met by the use of clamshell excavation in place of hand labor.

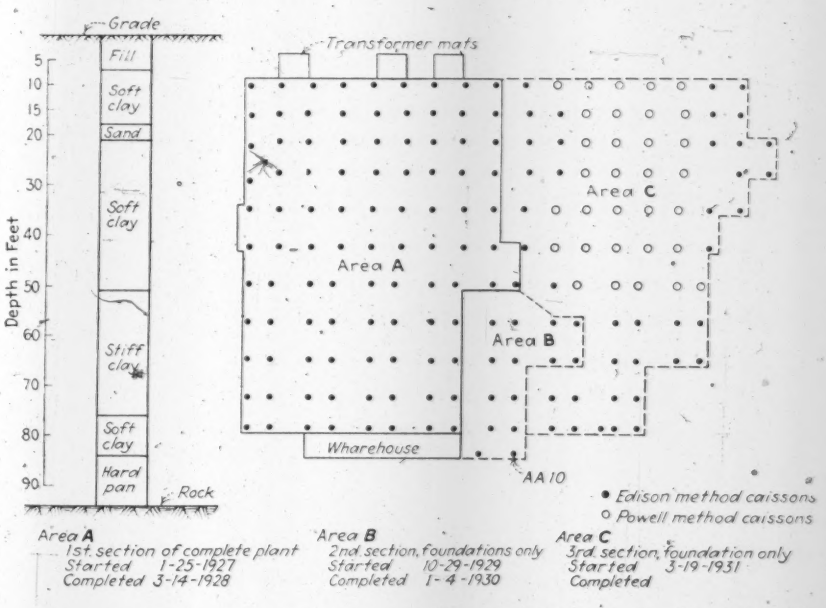


Fig. 1—Soil conditions and caisson plan at Delray power house, Detroit Edison Co.

Soil-pressure tests undertaken

Fig. 1 is a typical cross-section of the underground at the power plant; it is composed of clays of various consistencies. Tests of the lateral pressures of these clays are shown graphically on Fig. 2, which at a depth of 80 ft. indicates a lateral pressure of more than 5,000 lb. per sq.ft.—as great a pressure as that created by a head of water of the same height as this clay. The clay weighs about twice as much as water, or 126 lb. per cubic foot. The data for plotting these curves were obtained by Goldbeck cells placed through holes in the caisson lagging to make contact with the clay.

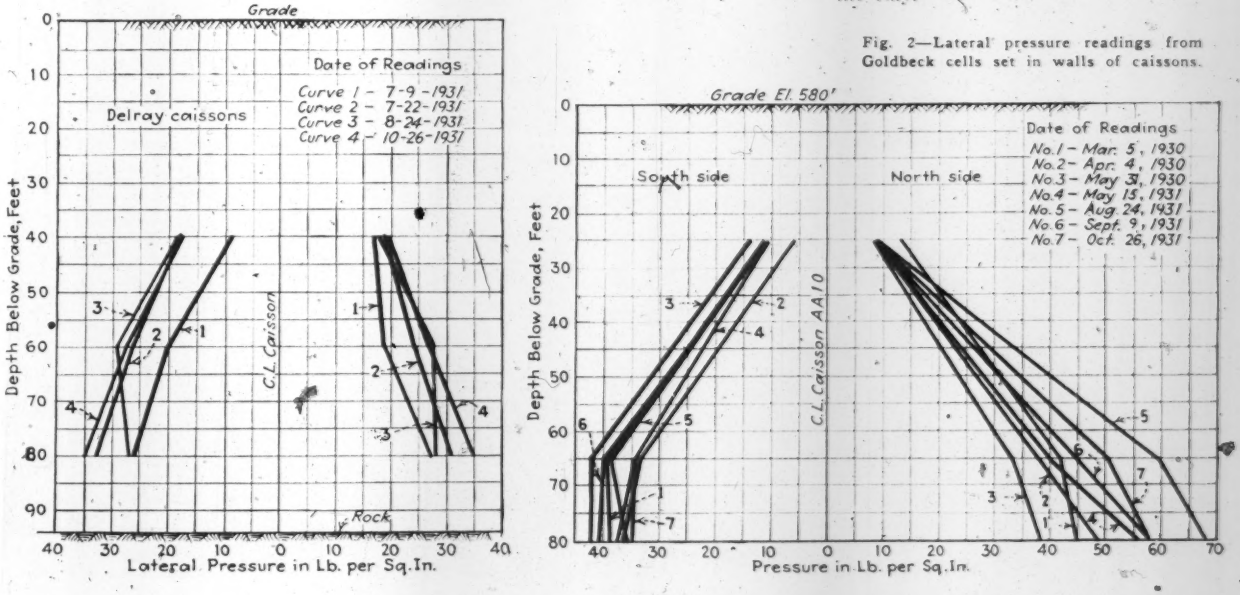


Fig. 2—Lateral pressure readings from Goldbeck cells set in walls of caissons.

About 25 cells were used in four caisson shafts, as a rule two cells for each horizontal section, with three horizontal sections per shaft. Lateral-pressure readings on three of these shafts have given no indication to date of unbalanced pressures—that is, the two cells at each horizontal section read the same. The fourth shaft shows a decided unbalance of pressure from the north to the south side. The location of this caisson with respect to past and present work is shown on Fig. 1. The underpinning of the adjoining warehouse was completed about eight months ago, and therefore its weight could not have influenced the readings since May 15, 1931, as plotted in Fig. 2*b*.

In general, Fig. 2*b* shows that pressures on the north side have been greater since May 15, 1931. Also on the south side the pressures concur more nearly with the other three shafts. A possible explanation for this building up of pressure on one side of the shaft may be a clay movement at the lower levels. The curves also show that the lateral pressure in this Rouge River material is greater than the values accorded clay in some handbooks.

New construction methods

The latest method of forming these caisson shafts has been to use the Powell system, which consists of a vertical drill churning through the clay in the presence of water and in a short time making a hole 4 to 5 ft. in diameter, 85 ft. deep to hardpan and filled with a soupy clay. A steel shell is then dropped into the hole and driven 1 or 2 ft. into hardpan for a seal. The soup is then bailed out. In so far as the escape of clay into the hole is concerned these latter methods have proved satisfactory except in isolated cases where boulders have projected up above the hardpan and made contact with only a part of the cutting edge of the shell. In cutting out such a boulder considerable soft clay can enter the shaft, and at the same time there is the real hazard of losing the hole.

Conclusions

The thought to be gathered is that when caisson shafts penetrate a clay formation that indicates a squeezing effect (and the experience at Delray shows how well clay can do this), the possible complications that might result from subsidence of the ground surface should govern largely the method used in sinking the shafts. There are two procedures that insure no subsidence: the well-known method of excavating under air pressure, and the less-known method of using the Powell system in conjunction with a core barrel to cut through occasional obstructions in the soft material, with the lagging cylinders finally grouted into the rock or some soft stratum. Both methods give a plumb shaft but require grouting of fissures in the rock if sulphur gas is known to be present, as it often is in the Detroit area.

Steel Arches Replace Three-Span Suspension Bridge Over Thames

DEMOLITION of the 65-year-old suspension bridge near Lambeth Palace and the substitution of a modern steel-arch structure comprise a large construction project that is nearing completion in London at the present time. The new bridge will provide an entirely new highway crossing of the Thames River because the old bridge has been used only by pedestrians since it was condemned in 1910. At the time of its construction in 1862, under the supervision of the designer, P. W. Barlow, the old structure was the largest wire-rope suspension bridge in England. It was also notable in that it utilized three 280-ft. spans with backstay anchorages in the Middlesex and Surrey shores of the river. The cables were fixed to the top of the towers, which consequently had to withstand heavy bending stresses.

The design of the new bridge was prepared for the London county council by its chief engineer, Sir George Humphreys, and the work is being carried out by Dorman, Long & Co., Ltd., under his supervision. The contract included the erection and subsequent removal of a temporary footbridge, as well as the demolition of the old bridge and the construction of the new one.

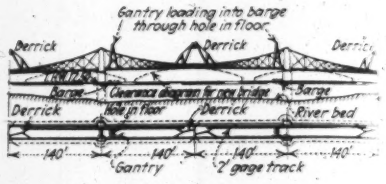


Fig. 1—Dismantling of old Lambeth suspension bridge was carried out by lightweight equipment prior to construction of new bridge. Old bridge contained three 280-ft. spans with cables fixed at the tops of the towers. All spans were dismantled simultaneously.

The new bridge consists of five spans—a center span of 165 ft., intermediate spans of 149 ft. and shore spans of 125 ft. A 36-ft. roadway and two 12-ft. sidewalks are provided.

Demolition of old bridge

The demolition of the old suspension bridge began in June, 1929, and the weakness of the structure necessitated careful attention in order to avoid the possibility of a total collapse. The first step consisted in reinforcing the towers, which were composed of angles and thin iron plating. Dismantling operations were commenced simultaneously in the centers of the three spans in order that the towers should not be subjected to bending stresses from unequal loading. Two 1½-ton derricks traveling on the floor system and moving each way from the center of each span toward the towers transferred the hangers and floor steel into barges in the river below.

With the floor system and hangers removed, the cables were lifted by a cathead erected over each tower and lowered across three barges, where each cable was cut at the middle by an oxy-acetylene flame and drawn into shore each side, clear of the navigation channel. Demolition of the towers was

Fig. 2—Erection of new bridge was carried out by 20-ton stiff-leg derricks on each pier. Note the troughed plates upon which reinforced-concrete roadway slab was poured.

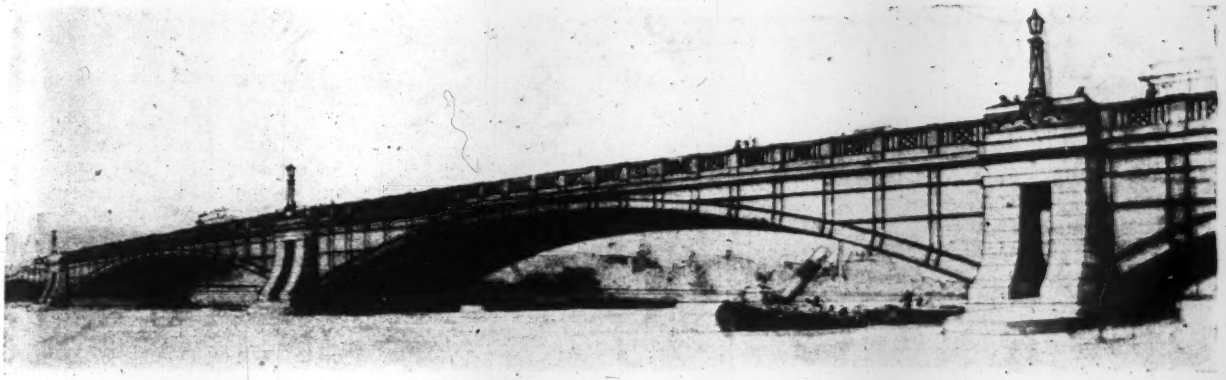


Fig. 3—Architect's sketch of new Lambeth Bridge over the Thames, London, comprising five spans of steel-rib arches and providing a new highway crossing of the river.

carried out by manually operated cranes of 3-ton capacity erected on pile falsework built around each pier.

Each of the old piers was composed of cast-iron segments 12 ft. in diameter, with a 3-ft.-thick internal brick lining. This lining was removed, with the exception of a small portion at the bottom of the cylinder, left to form a collar for jacking purposes. The cast-iron segments were dismantled to a level slightly above high water, and the remainder of each pier was lifted up by means of two 200-ton jacks, one of which operated from the falsework by a system of links and the other from the original concrete foundation base, acting against girders placed across the under side of the collar of brick lining. The jack on the original foundation base was used only to overcome starting friction and was then lashed to the girders it acted against, so that it was withdrawn by the upper jack as an integral part of the pier. As each section of the cast-iron cylinders was raised above the water level the segments were unbolted and removed.

Building new foundations

The four piers of the new bridge are constructed of steel caissons filled with concrete and sunk by means of compressed air to a solid foundation some 25 ft. below the riverbed. The caissons were braced with plate girders whose webs were pierced by 2-ft.-diameter holes to permit continuity of the concrete filling. The Westminster abutment measures 90 ft. along the river and 70 ft. at right angles to the river. Since it occupied the same site as the old abutment, the new foundation had to be constructed in four sections in open excavation. The first section extended the entire 90 ft. and was carried down to full depth. With this section filled with concrete approximately up to the springing line of the arches, it formed a dam behind which the rest of the work could be carried out. The remaining area was divided into three sections, each of which was excavated in turn, the middle section (containing the old foundations) being the last to be completed. The Lambeth abutment was constructed in the same manner, although work was not complicated by the presence of the old pier, which at this end of the bridge was some distance downstream.

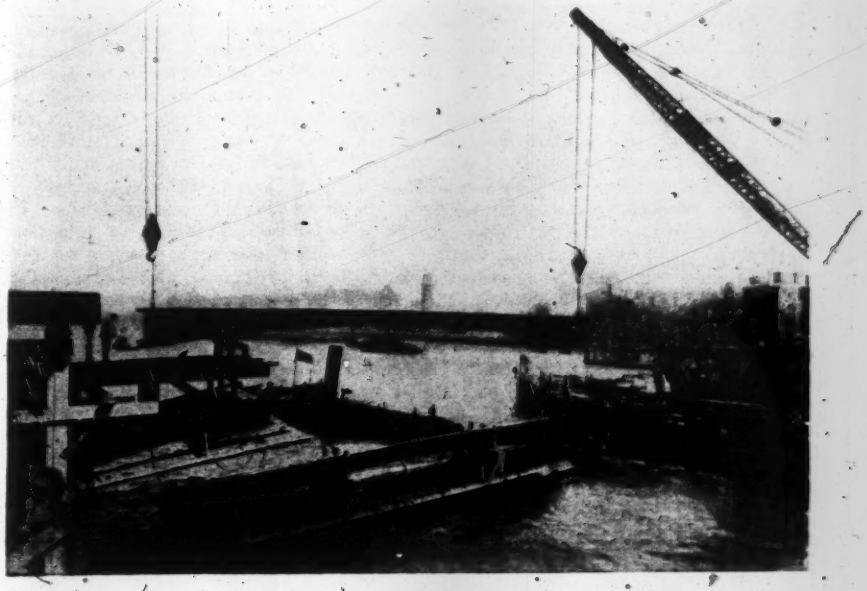
Superstructure erection

Erection of the steel superstructure began in the fall of 1930. Each span consists of nine-steel-arched ribs. Each rib was placed in three sections, two arms at each end and a center section. The roadway is carried on pressed-steel troughing laid directly on the floor system, expansion joints being provided over each pier.

In erecting the spans five 20-ton cranes were employed, one mounted in the middle of each pier. Erection of the superstructure was begun on the shore spans by placing the cantilever ends, supported at the pins, and by timber staging at the ends. The center sections were then brought into position and lifted by the two adjacent 20-ton cranes onto a special falsework equipped with adjusting jacks. Since the piers were not constructed to withstand the unbalanced thrust of more than three ribs at a time, no load was jacked into the shore-span ribs at this stage, and they were left resting in position on their falsework while the cantilever ends of the next spans were erected. These were supported on falsework in a similar manner, but as the channels crossed by the intermediate and center spans are navigable, the center sections of these spans had to be brought in on barges and lifted directly into position.

A special method of jacking from the bearings was then employed to put the rib into true form before the connections to the cantilever ends were riveted up, after which the jacks were again used to put the required camber into the rib. The information upon which this article is based was supplied by the editor of *Civil Engineering* (London) and by Dorman, Long & Co., Ltd.

Fig. 4—Middle sections of ribs of three center spans were transferred from barges directly to their position in the bridge, navigation requirements precluding use of falsework. Each rib was erected in three units.



Letters to the Editor

The Cement Differential

Sir—The article entitled "Demoralization of the Cement Industry" by O. Fred Rost, which appeared in the March 17 issue of your publication, has been read with a great deal of interest. It very accurately describes in a general way the development of the cement industry, the situation at present and a number of the evils that tend toward demoralization. However, some of the statements are not entirely correct, or at least are subject to wrong interpretation.

I have particular reference to that part of the article appearing under the subtitle "Vicious Dealer Differential Firmly Entrenched." I believe that this part of the article is subject to the inference that a great part of the drastic reduction that has occurred in cement prices during the past two years may be charged to the failure of the cement industry to accept an effort made in 1930 by one manufacturer and supported by many others to change the amount of and the method of handling the dealer's differential, such failure resulting in rather chaotic competition and leaving the dealer's differential entrenched.

An additional inference possible is that the dealer differential was in most cases not paid to regular dealers but generally went into the hands of itinerant dealers who, as political go-betweens or dummies, collected the 10c. per barrel differential from the cement manufacturers and passed it along to obtain political influence. The figures that the author has built up may be interpreted to show that this practice was very general and resulted in large sums of money, paid by cement manufacturers as dealer differential, going into the hands of the politicians. Assuming that others may draw the same inferences, I wish to express through your columns my opinion of these matters.

First, let us consider the matter of the dealer's differential and its effect on the present situation, without reference to the political factor. The dealer's differential, in one form or another and in varying amounts, has been one of the troublesome problems of the cement industry for many years. In the earlier days, when most of the large construction work was confined to municipalities where dealers actually rendered service, there was little or no objection on the part of the purchasers, but with the development of the concrete road and the extensive use of cement in large engineering projects outside of municipalities, there developed strong objection on the part of engineers and contractors to paying a dealer differential on such work. This created a condition that resulted in dealers very often reducing the 10c. differential that they ordinarily demanded from the cement manufacturers, and thereby reducing the price at which the engineer or contractor could purchase cement. Thus, even in times when prices on cement, so far as the manufacturers were concerned, were reasonably well stabilized, there was frequently an unsatisfactory price condition on contract work, caused by the variation in the differential asked by competitive dealers on a contract job.

Various of the cement manufacturers from time to time tried to correct this condition by establishing selling plans that would eliminate the dealer differential on such work. For years there was strong tendency among the cement manufacturers to do this; but the dealers' business was such a strong influence in their behalf that the manufacturers hesitated to take the step necessary to divorce the dealers from this contract work.

The attempt referred to by the author made in 1930 to correct this condition did not seek to eliminate the dealer differential. Rather it changed the name and the form and established the differential at 5c. While this, on paper, constituted a reduction from the previous 10c. differential, it actually raised it on most contract jobs, as the dealers for some years past had seldom, if ever, obtained as much as a 10c. differential on such work, and in many cases the differential was as low as ½ or 1c. per barrel.

When the 1930 attempt failed and the various manufacturers announced their plans of selling, it developed that out of the confusion a new method of selling was born, in that practically all the manufacturers established selling policies that limited dealer participation to contract work located in municipalities where dealers are prepared to, and do, render service, but eliminated it entirely from contract work located outside such municipalities. It was on this latter class of work that the contractors had objected to paying the dealer a differential.

There were some price reductions early in 1931 that might be attributed to the failure of the selling plan inaugurated in 1930, but such reductions were minor as compared with the very drastic reductions that have taken place in some parts of the country, which have been due almost entirely to lack of demand and the very keen, and in many cases unethical, competition that is always present under such conditions. The method now followed by practically all maunfacturers of eliminating dealer participation on contract work outside of municipalities has greatly reduced, if it has not entirely removed from the picture, the vexing problem of the dealer differential.

To consider the second inference, which I believe a most unfortunate one, that the dealer differential had been used to influence political favor. I think such an impression is entirely wrong. I make this statement not only because of my own knowledge, but after making inquiry of a number of other men who are well informed on the methods of selling in the cement industry, and neither I nor any of those consulted have even heard of a dealer's differential, as such, being used in the manner described by Mr. Rost to control political influence.

Don't misunderstand my statement. I do not mean to infer that politicians many not have been influenced in one manner or another, but I want to reiterate that I have never known of the dealer's differential being used for such purpose.

CEMENT MANUFACTURER.

New York, City,
March 26, 1932.

EDITOR'S NOTE—So much discussion, criticism and trouble has grown out of the dealer-differential practice that the above-stated facts are a valuable addition to the sketch of the situation given by Mr. Rost. If, as the writer of the letter suggests, the present methods of handling the differential practically remove all cause of trouble, this result undoubtedly will prove to be an important step toward placing the industry on a more satisfactory basis. The statement that the dealer differential has not been used as a means of obtaining political influence is also instructive, and because of the writer's wide knowledge of the field it is of high authority. But it can hardly be questioned that the possibility of misuse was inherent in the system.

A further point in the article under discussion has been questioned—namely, the author's reference to the single-quality standard and to special types of cement. The author informs us that these passages of his article are not to be construed as arguments for or against standardization or as expressions of doubt concerning the value of special cements. The merits of quality standards and of special products depend on technical considerations, while the article dealt only with distribution and price policies. It is a well-recognized fact that the maintenance of a single-quality standard was largely responsible for the growth of the cement-making and cement-using industries. The practical value of high-early-strength cements is equally well established. Nevertheless, it is held that both contributed in their final effect to the present bad commercial situation.

A correction is to be noted. In the sixteenth line from the end of the article (March 17, 1932, p. 407) the expected 1932 consumption was given as tons, which of course should have read barrels. An error in the price curve (p. 405) will be corrected by repeating the cut in the April 7 issue as part of Mr. Rost's second article; it will show the average 1931 price at mill as $1.10.

Correction—Truck-Mixed Concrete

In our report of the meeting of the American Concrete Institute (*ENR*, March 10, 1932, p. 372) A. A. Levison, of the Blaw-Knox Co., is quoted as expressing the opinion that long mixing with any type of truck mixer should not be counted upon to produce increased strength. This was incorrect. Mr. Levison's opinion is that increase of strength of concrete may be expected as the time of agitation is increased. He referred to results of a test continued for nine hours, which showed a

.3 per cent increase in strength with 20 min. of mixing, 5 per cent increase at 40 min., 10 per cent at two hours, 12 per cent at three hours, constant strength from three to seven hours, and slight retrogression in strength from seven to nine hours.

Underground Water Rights

Sir—The decision of the Supreme Court of Arizona in the case of Southwest Cotton Co. vs. Maricopa County Municipal Water Conservation District No. 1, summarized by Thos. H. Means in your issue of Jan. 28, is not the unmixed blessing that your editorial comment would lead one to believe, since, instead of hastening development in this state by removing a menace to the utilization of such surface-water supply as is still undeveloped, it places a serious obstruction in the way of the development of a resource far more important economically, viz., the great underflow of the valleys of southwestern Arizona.

This decision appears to be based, not on any provision of statute or present-day law defining respective rights of appropriation of surface and underground waters, but upon the fact that the statutes ignore the underground waters in defining rights of appropriation, and that therefore the legislature, presumably, in its various modifications of the water code, intended by omission to deny the right of appropriation to any water not flowing with a definite and perceptible velocity, either in an established watercourse on the ground surface or a similar course, in the nature of an underground tunnel, similar to the streams that sometimes exist in cavities in formations of limestone and gypsum. (An anomaly of the situation appears in the fact that no such underground streams are known to exist in this state.) This omission or ignoring of underground waters leaves the state subject to the basic law that has come down through the centuries, which assumes, in effect, that under each owner's boundary line an impervious wall extends to an indefinite depth, that no water can get in or out, and the owner is entitled to all of the water underlying his property. This principle is no more applicable to Southwestern water conditions since the development of efficient pumping machinery than the highway codes of the last century are to present-day traffic.

In the more humid regions the streams collect the underground waters and serve as drainage channels for the valleys through which they pass, increasing in size as they approach the sea. In the valleys of the Southwest the reverse is true. When the stream leaves the canyon that forms its course through the mountains where its source lies, its volume immediately decreases progressively as it traverses the valley, until (except in the case of the major rivers or occasional runoff floods) it completely disappears. The water passes into the underflow of the valley, and there is built up and maintained an immense body of water slowly moving through the formations of unconsolidated boulders and gravel underlying the valleys to the sea.

Over considerable areas this underflow is within economical pumping depths, and in many cases the material through which it flows is so course and loose in texture that yields of from 5 to 10 cu.ft. per second from a single drilled well are common. Furthermore, these areas of low pumping lift and abundant yield underlie or are contiguous to the lands best fitted, for various physical and agricultural reasons, to profit by their use.

Fluctuations in rainfall from year to year over long periods are so extreme in this region that an anticipated storage and use of surface water based on the annual runoff invariably results in shortage of actual supply, not merely for a short period in any one year, but for continuous periods of several years' duration. A stream record may show an average runoff of 250,000 acre-ft. per annum, and at the same time a discharge for a four- or five-year period not exceeding 20,000 acre-ft. annually. Construction of large storage works and their attendant delivery systems would seem obviously uneconomical in such cases, yet it was in the face of such conditions that the defendant in this suit, at great expense, constructed its storage reservoir, with a capacity of 170,000 acre-ft., cutting off practically all of the underflow of the valley below except during the rare seasons, years apart, when the flow of the river is in excess of the reservoir capacity. The plaintiff, who is successfully operating large holdings in the valley by use of pumped water, is denied protection against the cutting off of his water supply because the water of the river, having passed into the ground, is no longer subject to appropriation unless he can show the court the exact location and extent of the underground channel through which it flows.

Storage of surface waters for irrigation, on streams where this conflict of uses becomes a consideration of any importance, has gone about as far as it can economically, under present-day conditions, in this region, but there will continue to be developed, on the top of waves of economic prosperity when large amounts of capital are seeking an outlet, border-line projects which, under the combination of water shortage and financial depression, will result in calamity to landholder and bondholder alike. Several pumping projects have been successfully developed, with ample water, in situations susceptible to such surface storage, and are therefore under the law as clarified by the court imperiled by the possibility of depletion of their water supply by surface projects that turn out to be economic failures. There is no case on record of a storage project in Arizona being abandoned or delayed through fear of litigation with users of pumped water, but it seems quite probable that many an otherwise meritorious pumping project will at least be scrutinized very carefully in the future, in fear that some ill-advised surface storage scheme may appropriate its water and leave it, not high, but dry.

The underflow is, as has been demonstrated, the river itself. Contributions to the underflow from the side washes are normal accretions to streamflow, while the seepage from rainfall on the ground is certainly only a minor contribution in this region of 7-in. annual rainfall and 80-in. annual evaporation. The materials through which the underflow passes were placed there by the stream in the channel as it existed at the time, and experience in the development of underground waters and study of their action has demonstrated that it is only where these materials have been so placed that the water is economically recoverable for irrigation.

It would seem reasonable to believe that the legislature, in drawing up statutes defining rights of appropriation of water intended only to give attention to such waters as could be reasonably appropriated, and that, since at the time these laws were written the art of drilling and casing wells and of pumping water in large quantities from such wells was yet undeveloped, the appropriation of underground waters was omitted from consideration because there was no way to utilize them to any extent that could cause a conflict of rights. Moreover, the source of this groundwater had not, at that time, been demonstrated or even investigated.

Is it not then reasonable, since the use of these underground waters by pumping has become economically important, to regard the principle of established bed and banks in the surface stream to apply as well to the underground conditions where the waters are moving no less in a definite course through channels once exposed but now covered and more or less clogged with boulders, even though it be impossible without extensive exploration to see or know exactly where the edge of that channel may be?

In the opinion of the writer, the court, instead of clarifying the law and removing obstructions to future progress in water development in Arizona, was more successful in calling attention to the fact that our law was so inadequate for present-day conditions that in order for development to continue there must be a revision of our water code that will give to our underground waters the standing in law to which they are entitled by all the rules of common sense.

SHELDON K. BAKER,
Reed & Baker, Consulting Engineers.
Phoenix, Ariz.,
Feb. 12, 1932.

NEWS OF THE WEEK

Philadelphia Region Plan Completed and Made Public

A FORECAST of the development and requirements of 50 years hence for the region of Philadelphia has been announced by the Regional Planning Federation of the Philadelphia Tri-State District. A 500-page report, the result of four years' work, was presented March 16 to the board of directors and numerous committee members.

A population of 6,500,000 is predicted for 1980. It is anticipated that 1,200,000 people will be engaged in industry 50 years hence, against 675,000 at present, and that double the existing area will be required for industrial use.

Some of the recommendations in the plan are as follows: belt line highways supplemented by crosstown radial routes; seven new bridges or tunnels for the Delaware River and five for the Schuylkill River; development of Hog Island as a marine-air-rail terminal; central Philadelphia waterfront as a modern pier group, a marine-rail terminal at Trenton, Howells Cove, expansion of the Wilmington port along the Delaware and Christiana rivers and completion of the Camden marine terminal; five additional airways, an additional air transport terminal, 25 aerial service bases, seven new landing fields; 800 miles of parkways in stream valleys; 130,000 acres of parks; interchange and interconnection of water supplies in the Camden and Trenton areas; sewage treatment.

By 1980, it is estimated, the water consumption of the region will be 830 m.g.d. and should come from upland sources, in place of the present supply from the tidal portion of the Delaware and lower reaches of the Schuylkill. Already the state has started conservation of the upper Delaware above the Lehigh River by requiring complete treatment of sewage and industrial wastes in that watershed. Early agreement is urged between Philadelphia and other communities affected on a development policy of upland streams.

Samuel Price Wetherill is president of the federation and W. H. Connell is executive director.

Progress in Fixing Standard Bridge Clearances

Work of establishing standard clearances for proposed bridges to cross important waterways in the United States is making steady progress. Gen. Lytle Brown, Chief of Engineers, has recently announced standard clearances for the tributaries of the lower Mississippi River, the Connecticut River, the Lake Washington ship canal, and Coos Bay, Washington.

In the lower Mississippi River basin standard clearances have been established for the following rivers and their important tributaries: St. Francis, White, Arkansas, Yazoo, Black, Ouachita, Tensas, Red, Old and Atchafalaya.

The clearances established for these streams may be ascertained by communicating with the district engineer of the district in which the stream is located, or directly with the office of the Chief of Engineers, Washington, D. C.

Suit to Restrain Building of Pine Canyon Dam

A suit asking an order to restrain the city of Pasadena, Calif., from building a dam in San Gabriel Canyon at the entrance of Pine Canyon has been filed in the Los Angeles County superior court by the San Gabriel Valley Protective Association. Asserting riparian rights, the plaintiff association is contesting the proposed construction of the dam on the ground that impounding the water would deprive the communities downstream of its use.

Seek Reemployment for Los Angeles Technical Men

Action looking toward reemployment of city employees recently dismissed because of lack of funds, by means of a general reduction in salaries and working time, was taken March 23 by the Los Angeles, Calif., city council. On recommendation of the budget committee, the council instructed the budget and efficiency director to make a survey and submit a detailed plan whereby the 211 technical men recently discharged in the bureau of engineering may be replaced on the city payrolls. If the plan works in the bureau of engineering, it may be possible to reemploy others dismissed.

Retrenchment ordinances that have been adopted by the council caused the dismissal of 341 employees and have placed most departments on a five-day week. A salary reduction ordinance, calling for reductions of from 2 to 10 per cent, will become effective April 1.

New York City Calls for Subway Operation on Fee Basis

BIDS for the operation of the new municipally built Eighth Ave. subway system in New York City have been called by the board of transportation of the city of New York. Bids are to be opened on April 26.

The board of transportation states that upon execution and delivery of the contract and lease it expects to have ready for operation the main trunk of the system, extending from 212th St. south through Manhattan Island to Fulton St., together with the storage and repair yard at 207th St. along the Harlem River; further, about Jan. 1, 1933, the Bronx Concourse line from East 205th St. in the borough of Bronx to 149th St. at St. Nicholas Ave. in Manhattan, together with the storage yard and inspection facilities on the reservoir site in the Bronx, also the Prospect Park and Coney Island line in Brooklyn, which is a continuation of the main trunk in Manhattan Island under the East River at Fulton St.; also the first portion of the Queens Boulevard line from Eighth Ave. and 53d St. in Manhattan to Roosevelt Ave. in Queens, and the first portion of the Brooklyn crosstown line from Nott Ave. in Queens to Nassau Ave. in Brooklyn will be ready for operation.

About July 1, 1933, the first portion of the Houston and Essex St. line will be ready from Sixth Ave. to Madison St. in Manhattan, and about Jan. 1, 1934, the remainder of the line passing under the East River to Jay St. in Brooklyn will be ready, together with the Fulton St. line from Court St. to Rockaway Ave. in Brooklyn. About Jan. 1, 1935, the second portion of the Brooklyn crosstown line from the intersection of Lafayette Ave. and Fulton St. to Manhattan Ave. will be ready and the second portion of the Queens Boulevard line from Roosevelt Ave. to and along Hillside Ave. to 178th St., Queens, together with storage yard and inspection facilities near Union turnpike in Queens. The remaining portion of the system, the Sixth Ave. line in Manhattan, is to be ready about Jan. 1, 1938.

The proposed form of contract calls for the bidder to be able to prove to the satisfaction of the board of transportation that it has free and liquid assets of an amount of at least $750,000, also for the deposit of a certified check for $150,000 with the bid. The bidder is to specify the amount it is to receive as deduction from gross revenue as compensation for its services for stated periods during the life of the lease, these deductions to be junior only to operating expenses and maintenance expenses. Such deficits as occur in meeting operating and maintenance expenses shall be supplied by the lessee from its own resources, for which it shall be reimbursed subsequently when gross revenue exceeds operating and maintenance expenses and its prescribed allowances. Deficits in its own allowances are to be cumulative, without interest, but only to the extent that they fall short of 6 per cent upon the lessee's capital of $750,000 plus necessary investment by the lessee in materials and supplies. After deductions for operating and maintenance expenses for allowance to the lessee and for a fund for depreciation and replacement, any balance remaining in the gross revenue is to be paid by the lessee to a reserve fund board for such purposes as the board of transportation may direct.

The contract is to run until June 30, 1941, and is renewable in ten-year terms. It calls for a 5c. fare.

Kentucky Bridge Built for $270,000 Under Estimate

Reduction in construction costs has been strikingly shown in the case of the Eggners Ferry bridge, in western Kentucky, built by the Kentucky highway department. The original estimate was $870,000, but the cost of the bridge completed was less than $600,000. The bridge is of concrete and steel, 20 ft. wide, with two traffic lanes. Work was started in November, 1930, and the bridge was opened on March 25 last.

Accord Near on Development of St. Lawrence Power

As the result of a series of conferences between Premier Bennett and Premier Henry of Ontario, the basis of an agreement has been reached for joint action by the dominion and provincial governments in power development in the international rapids section of the St. Lawrence. According to a statement by Premier Henry, Ontario's share of the estimated cost of the undertaking would be $115,000,000, including $75,000,000 for the construction of works common to both navigation and power, such as dams and other substructures, and $40,000,000 for the construction of power houses and the installation of machinery.

It is estimated by engineers of the Ontario Hydro Electric Commission that the total power available as Ontario's portion from the St. Lawrence is 900,000 hp., and that the cost would be about $15 per horsepower, which, with the additional cost of $3 for transmission, would bring the price up to about $18 per horsepower. Negotiations have so far advanced that a definite agreement is expected shortly.

The provincial hydro-electric commission is anxious to push the matter to completion to provide against a possible shortage of power, the demand for which, before the period of business depression set in, was increasing at the rate of 100,000 hp. per year.

Milwaukee Work Relief Reaches High Point

During March 4,700 men were certified for employment on city work in Milwaukee as part of the city's emergency program to relieve unemployment. Each man was given work for two weeks, as described in *ENR*, Nov. 12, 1931, p. 767. The men have been hired through the civil service commission and assigned to various public improvement projects. During February 4,266 men were employed in this way and they earned $198,420.

Registration of the unemployed applicants for work was begun this winter on Oct. 1, 1931. The total number registered up to March 18, 1932, was 19,567. On the corresponding day last year the number was 7,728. Certification for work relief has been given to 14,700 so far. The number has increased steadily each month: 350 in October, 950 in November, 1,200 in December, 3,000 in January, 4,500 in February and 4,700 in March. It is not considered possible to give a second opportunity for work to any of the list, and hardly likely that all the 4,500 or more not yet given assignments will be employed before the funds run out.

With the funds now available the relief program is due to be sharply curtailed. The number of work assignments for the March 18 shift was 2,200. If no adjustment is made in the appropriations made to the various city departments, the number will drop to 1,400 on April 1, to 700 on April 15 and to 200 on May 1.

HIGHER BARRIERS FOR RIVERSIDE DRIVE VIADUCT TRAFFIC

To prevent the increasing number of fatalities caused by motor cars mounting the curb of the 125th St. viaduct on Riverside Drive, New York City, and crashing through the railing to the street 75 ft. below, the New York city department of plant and structures is erecting a heavy plate girder barrier inside of the present curb, which itself is 14½ in. high. The new girder is about 20 in. deep. Its base is riveted to the viaduct steel and will be inclosed in concrete to the present curb level. The girder is heavily braced against impact by kneebrace stiffeners on the sidewalk side. A length of about 200 ft. of the viaduct will be protected with this new barrier initially as an experiment, according to Edward A. Byrne, chief engineer of the department.

Contract Awarded for San Gabriel Dam No. 2

Contract for the construction of Dam No. 2 of the Los Angeles, Calif., county flood-control project in San Gabriel Canyon has been awarded the Macco Construction Co. and the Lewis Construction Co. on their joint low bid of $2,086,950.

The dam will be of the rockfill type, 245 ft. high with an 800-ft. base.

Openings for Engineers in New York Civil Service

The New York State Civil Service Commission will hold examinations on April 23, for which applications must be filed not later than April 9, for assistant engineer (gas), department of public service, state division, Public Service Commission. The salary, it is announced, is more than $3,240 and there is one immediate appointment expected at $4,200. The duties of the position include taking charge of the engineering personnel (gas) of either the Albany or the New York office under the general direction of the gas engineer and to act independently in his absence.

Another examination will be held on the same day for inspector of equipment, department of public works. The salary for this position ranges from $2,641 to $3,240, with an immediate appointment expected at $3,000. The duties include setting up and maintaining a complete system for the purpose of providing a perpetual inventory of all machines and machine repair parts used on canal locks, power houses, lift bridges and floating plant; also all construction equipment tools, repair parts and materials used in the construction and maintenance of the canals and highways, and to determine relative mechanical value and condition of such equipment.

Further details may be obtained on application to the Civil Service Commission, Albany, N. Y.

Construction League Organizes With 14 Charter Members

Permanent organization of the Construction League of the United States was accomplished at the meeting of the League's assembly at St. Louis on March 21-22. Fourteen national associations enrolled as charter members. Officers are: General chairman, Robert D. Kohn, president of the American Institute of Architects, New York; vice-chairmen, Francis Lee Stuart, president of the American Society of Civil Engineers, New York, and A. P. Greensfelder, past-president of the Associated General Contractors, St. Louis; treasurer, J. C. Bebb, secretary of the Producers' Council, Boston; general secretary, P. W. Donoghue, president of the National Association of Master Plumbers; executive secretariat, E. J. Harding, managing director of the A.G.C.; E. C. Kemper, executive secretary of the A.I.A., and Charles M. Upham, engineer director of the American Road Builders' Association.

The assembly passed a resolution in favor of preserving the gasoline tax for highway purposes exclusively. Construction finance was discussed. A committee was named to study grade-crossing elimination.

California Refuses Further Aid to State Land Colonies

The California state finance director has informed the banks holding loans against landholders in the Delhi and Durham colonies, the two state land settlements, that there will be no further state aid for the colonies and the law must take its course with those who have failed to pay out on their land. This decision leaves the problems of carrying loans on the 8,600 acres in the Delhi colony and 4,316 acres in the Durham colony directly up to the banks.

California definitely decided to retire from its state aid land settlement program in 1930 when an adjustment procedure mutually acceptable to the 232 contractual holders of the Delhi colony and the state administration was instituted. At the same time adjustments were made to permit the state's withdrawal from participation in the Durham colony affairs (*ENR*, Oct. 9, 1930, p. 588). The state set April 10, 1931, as the date to sell all unsold and repossessed farms in the Delhi colony to the highest bidders and set a later date to sell the unsold land in the Durham colony (*ENR*, April 2, 1931, p. 575). This final action by the state definitely closes this state land settlement program.

San Francisco to Vote on $6,500,000 Hetch Hetchy Bonds

A $6,500,000 Hetch Hetchy bond issue will be submitted to the voters of San Francisco, Calif., on the May 3 ballot to provide funds for the completion of construction on the Hetch Hetchy system. The amount asked is based on estimates presented by M. M. O'Shaughnessy, consulting engineer. Of the total, $5,286,000 is for completion of the Coast Range tunnels and connecting pipe line; $1,000,000 for construction of roads in accordance with the city's Hetch Hetchy agreement with the government; and $214,000 for interest on the bonds during construction.

Louisville Markets Bonds for Sewer Construction

A legislative act empowering the city of Louisville, Ky., to sell city bonds at less than par, if necessary to market them, assures that work under way or planned by the sewerage commission will be carried to completion. Immediately after the passage of the act $500,000 of 4½ per cent bonds were disposed of, and an option was given for $1,500,000 of additional bonds. It is stated that steady employment is insured for more than 4,000 men in sewer construction work.

Non-Union Labor Does Not Void Contract, Ohio Court Holds

That public officials cannot refuse to award a contract to the low bidder on the sole ground that the bidder does not employ union labor is declared by the Ohio supreme court in a decision handed down in the case of the United District Heating Co., Cleveland, against the Ohio State Office Building Commission. A mandamus suit was brought by the heating company to compel the commission to award a contract for the construction of a heating tunnel from the Ohio penitentiary to the state office building. The heating company's bid of $72,965 was low and the commission at first declared it would award the contract to the company but later sought to rescind its action on the ground that the company would employ non-union workers. The court declared that public officials cannot exercise such discrimination.

William A. Starrett, Builder of Skyscrapers, Dies

William A. Starrett, president of the Starrett Corp. and vice-president of Starrett Brothers & Eken, recent builders of the Empire State Building, the Manhattan Company, New Metropolitan Life, Starrett-Lehigh and McGraw-Hill buildings in New York, the Carew Tower in Cincinnati and the Ramsey Tower in Oklahoma City, died at his home in Madison, N. J., on March 26 following an illness of about two months. Col. Starrett also was president of the Associated General Contractors of America. His election to that office took place in January, only a few days after he was stricken on Jan. 19.

William A. Starrett.

W. A. Starrett was born in Lawrence, Kan., June 14, 1877, attended preparatory school in Chicago and studied civil engineering at the University of Michigan. His active career in the construction industry began with the George A. Fuller Co., where he served in various capacities until he became superintendent. Leaving the Fuller company in 1900, he joined with others in the formation of the Thompson-Starrett Co. He remained with that organization until 1913, when he left it to join the firm of Starrett & Van Vleck.

In 1916 Mr. Starrett joined the Plattsburg Training Camp and the following May was made chairman of the emergency construction committee of the Council of National Defense, being commissioned a major in the Engineer Reserve Corps in June, 1917. He was promoted to the rank of Colonel, Q.M.C., the following March. As chairman of the emergency construction committee he had charge of the army building program, including cantonments and supply bases in this country.

Upon his discharge from the army Col. Starrett returned to the George A. Fuller Co., serving as vice-president from 19[illegible] to 1921. During this period he participated in the introduction into Japan of the use of steel frame buildings especially designed to resist earthquakes. In 192[illegible] Col. Starrett left the Fuller company to join with his brothers, Paul and Ralph, in forming Starrett Brothers, Inc.

Col. Starrett was the author of many magazine articles and of a book entitled "Skyscrapers and Men Who Build Them."

In recent months, until the time of his illness, Col. Starrett took active interest in emergency relief measures, nationally as a member of the President's Organization on Unemployment Relief and locally as a director of the New York Emergency Relief Committee.

Col. Starrett was a member both of the American Society of Civil Engineers and of the American Society of Mechanical Engineers. As a vice-president of the Associated General Contractors during the past year he had been very active in the affairs of that organization and was preparing to go to Milwaukee to take over its presidency when he was taken ill.

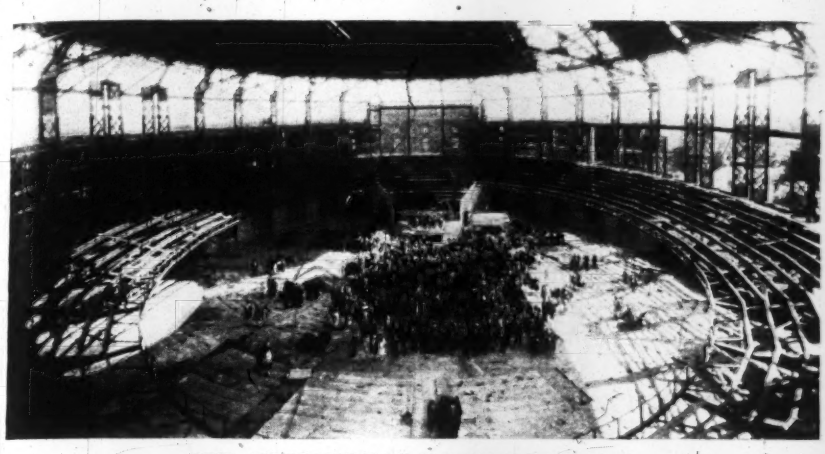
Support of Public-Works Program Urged by Civil Engineers

Support of a program of sustained public works by the federal government, states and municipalities was indorsed at the regular spring business meeting of the American Society of Civil Engineers held in New York on March 28 just preceding the regular monthly meeting of the Metropolitan Section of the society. Attention was called to the fact that in view of the increase in unemployment among engineers despite all relief measures the Professional Engineers Committee on Unemployment, representing the metropolitan sections of the Founder Societies, had sent representatives to Washington to appear before the Senate committee considering the LaFollette public-works relief bill (Senate bill 2419) to urge a large program of public works as the best means of relieving general unemployment. These representatives did not indorse the bill under consideration in its entirety but did indorse the principle of assisting local governments to finance useful public construction.

This action by the P.E.C.U. was indorsed in a resolution adopted at the meeting; further, all local sections of the society were urged to give their indorsement to movements calculated to stimulate public construction for unemployment relief.

Suspension Bridge to Be Built Over Rio Grande

The San Antonio Bridge Co. has awarded the contract for the construction of an international suspension bridge across the Rio Grande at a point a few miles south of San Benito, in the lower Rio Grande Valley. It is planned to lay out and develop a townsite on the Mexican side of the river near the bridge end, according to T. B. Bromley of San Antonio, manager of the company. Permits to construct the bridge have been granted by Congress and the Mexican government. It will make the sixth bridge to span the Rio Grande in the lower valley.



NEW AUDITORIUM IN INDEPENDENCE, MO.

Designed to accommodate religious gatherings, a new auditorium in Independence, Mo., involves several features of structural and architectural interest. The auditorium, main floor and 27-ft. cantilever balcony seat 7,000 persons. The structure is elliptical in plan with a major axis of 214 ft. and a minor axis of 168 ft. Thirty-two columns on the perimeter support a domed roof that rises 120 ft. above the floor. The columns are designed as latticed framework with door openings through a majority of them. A large central skylight 56x35 ft. is framed by two main trusses spanning the auditorium and weighing 58 tons apiece. Ten other trusses are included in the roof framing. The roof is gunite 2 in. thick with ornamental concrete ribs placed over the 32 radial expansion joints. A total of 1,400 tons of structural steel was utilized in the building. One cantilever balcony ties in with the speaker's platform and provides unlimited expansion for chorus uses. The semicircular orchestra platform will rise to enlarge the speaker's platform or sink entirely out of sight when required. Henry C. Smith, Independence, Mo., was the architect. The building was erected by the L. W. Weeks Construction Co.

Los Angeles Water and Power Department Shows Profit

H. A. Van Norman, general manager of the water and power department of Los Angeles, Calif., in his annual report announces net profits for the fiscal year of $6,450,659. Gross earnings were $25,371,123, of which $15,380,053 was for sale of electricity and $9,991,070 for sale of water. The electric system showed a net return of $4,344,289, an increase of about $110,000 over the previous year, and the net for the water system was $2,106,370, a decrease of about 18 per cent, which is explained as due to the increased cost of operation because of pumping water from underground basins to supplement the surface supply.

Plan 1933 Railway Exhibit

Although the usual exhibit was omitted at the recent convention of the American Railway Engineering Association, it is planned already to hold this exhibit next year, according to a statement made by A. S. Anderson, retiring president of the National Railway Appliances Association. Officers elected at the annual meeting of the appliances association include: president, Frank McAllister (Kalamazoo Railway Supply Co.); vice-president, A. Chapman (Rail Joint Co.); secretary (reelected), C. W. Kelly (Oxweld Railway Service Co.), Chicago.

To Investigate Causes of Automobile Accidents

Approval of plans for an extensive program of research by federal government agencies to determine the causes of automobile traffic accidents and congestion and to develop remedial measures which may be applied by the states and municipalities in dealing with the problem has been announced by Secretary of Commerce Lamont, general chairman of the National Conference on Street and Highway Safety. The U. S. Bureau of Public Roads will carry on the principal research work, and other government agencies, particularly the Bureau of Standards of the Department of Commerce, will cooperate in special investigations.

Reduced Program Forces Cut in New York Highway Staff

Because the amount of highway construction to be carried out by the New York state department of public works has been reduced from over 1,000 miles during 1931 to about 325 miles for 1932 a drastic cut is being made in the engineering force of the department. In order to retain in the service those men of most value to the state, Frederick Stuart Greene, superintendent of public works, has announced that the number of men in each grade necessary to carry on the highway work has been determined and, beginning at the top, this number will be assigned to each project. The remainder will be demoted to the next lower grade and used to fill the requirements of that grade, and so on down the line. This will result in concentrating the cuts in the lower grades. Salary limits will be unchanged.

Report on Home Finance and Taxation Due Next Month

The President's Conference on Home Building and Home Ownership will publish next month its report on home finance and taxation. This phase of the conference's work has aroused more interest than any other, and incidentally has brought strong support for enactment of the home loan discount bill. The opposition of large banking interests remains the principal obstacle to the bill. The President's conference published this week the first volume of its reports. Under the title "Planning for Residential Districts" are presented the final reports of the committees on city planning and zoning, subdivision layout, utilities for houses and landscape planning and planting.

Washington Notes

By Paul Wooton

Washington Correspondent

OPPOSITION that has developed in the Senate to the $120,000,000 emergency federal-aid highway bill has temporarily delayed the passage of the measure. Senator Vandenberg, of Michigan, and Senator Bingham, of Connecticut, who are leading the opposition, contend that the bill would penalize the more populous states that have finished most of their essential roadwork and would favor Southern and Western states. Amendment that would allocate the funds wholly on the basis of population was suggested. Despite the fact that a vote is being delayed, the advocates of the measure plan to continue their efforts until they are finally successful. They are convinced that the opposition has not sufficient strength to defeat the bill and is, therefore, employing parliamentary tactics to delay a vote as long as possible. At present the filibuster against the bill shows no indication of abating. The bill will continue to come before the Senate when it is reached in the periodic consideration of the calendar, but it has little chance in the near future of being made the unfinished business. Without that preferred status the measure can be considered only during the morning hour, when it is easy for even one Senator to prevent a vote. At present the tariff bill is the unfinished business and appropriation bills and other measures are in the offing. There is little prospect of the steering committee giving any consideration to the emergency bill until after the revenue bill has passed the House.

Would Expedite Work on Rivers and Harbors

The opportunity for stimulating employment that would be afforded by an expanded rivers and harbors program is being given increasing recognition by House and Senate leaders, according to members of the rivers and harbors committee, who are enlisting support for legislation authorizing a $500,000,000 bond issue for the immediate completion of projects. A growing tendency has been noted to regard an expedited rivers and harbors program as more practicable than many of the relief plans proposed.

Many members of Congress have become convinced that a public building program would require too much time to be started, because land has to be acquired and individual plans have to be drawn before the work furnishes much employment. Rivers and harbors work has been planned years in advance so that rapid expansion is possible if additional funds are made available.

Brief News

PLANS have been approved by the war department for the construction of a bridge by the Connecticut River State Bridge Commission across the Connecticut River at Hartford.

BIDS will be asked soon by Norwalk, Ohio, for the construction of a sewage-reduction plant, to cost $200,000, as the final step in completing the city's $475,000 sewage-disposal system.

CONTRACTS for municipal improvements aggregating $1,000,000 will be awarded by the city of Dallas, Tex., within the next 60 days, including storm sewers, street paving, the Lemair-McKinney underpass, and improvements at the Love aviation field.

A STATEWIDE ORGANIZATION of men prominent in construction, transportation and shipping interests was started in Buffalo, N. Y., on March 23. The new organization is called the Public Works Unemployment Relief Association and will work for increased highway and public-works appropriations.

CONTRACTS FOR RELIEF WORK have been awarded by the city of Montreal as follows: to A. F. Byers & Co., Ltd., for a gymnasium and public hall in Notre Dame de Grace, $220,000; to Ulric Boileau, Ltd., for the reconstruction of St. Denis St. subway, $120,000, and to R. & E. J. Ryan & Co., Ltd., for a comfort station in St. Ann ward, $58,765.

A MASTER DRAINAGE PLAN for the entire city of Dallas, Tex., has been proposed by John N. Edy, city manager, and the proposal has been tentatively approved by the city council. W. W. Horner, consulting engineer, of St. Louis, who has been in charge of storm sewer projects in the city, has recommended building eight additional lateral storm sewers out of funds saved by lowered costs of construction on several major jobs, three of which are now under way.

COSTS AND CONTRACTS

ENR Index Numbers

	Cost			Volume	
March,	**1932**	**157.24**	**Feb.,**	**1932**	**105**
Feb.,	1932	161.82	Jan.,	1932	121
March,	1931	194.51	Feb.,	1931	198
Average,	1931	181.35	Average,	1931	220
Average,	1930	202.85	Average,	1930	260
1913		100.00	1913		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of March 31, with some comparisons, total as follows:

(In Thousands of Dollars)

	Week of March 31, 1932	Average Week March, to Date	Average Week March, 1931
Engineering Construction			
Federal government	2 330	$3 002	$16 500
State and municipal	6 916	7 264	25 800
Total public	9 246	10,266	42 300
Total private	8 154	6 944	19 500
Grand total	$17,400	$17,211	$61,800
Cumulative, all classes, Jan. 1 to March 31:			
1932			$253,570
1931			663,083

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 20-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Yellowstone National Park, July 9.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Memphis, Tenn., May 2-6.

AMERICAN WELDING SOCIETY, annual meeting, New York City, April 27-29.

NEW ENGLAND SEWAGE WORKS ASSOCIATION, annual meeting, Boston, April 25.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, 40th annual meeting, Oregon State College, Corvallis, June 29-July 1.

CENTRAL NEW YORK CHAPTER, Associated General Contractors of America, at its annual meeting in Utica on March 23 elected the following officers: president, E. H. Stetson; vice-president, Waldo Griffith; secretary-treasurer, W. Gerard Hughes. All the officers reside in Utica.

CITY MANAGERS' SECTION, League of California Municipalities, held its annual conference in Bakersfield March 4 and 5, attended by 50 delegates. James S. Dean, city manager of Sacramento, presided. During the first day of the meeting round-table topics of discussion included unemployment relief, reduction of taxes, methods of assessment, garbage collection, water rates and increased activities of certain departments during the present depression period. "Comparative Cost of Government in California Cities" was the main topic of the second day's discussion.

AMERICAN GEOPHYSICAL UNION meets April 28 and 29 in Washington, D. C., at the National Academy-Research Council Building. Of particular interest to hydraulic engineers is the second meeting of the section of hydrology on April 28, to which reports will be presented by committees on snow, glaciers, evaporation, absorption and transpiration, runoff, physics of soil moisture, underground water, dynamics of streams, and chemistry of natural waters. Surveys of research done or under way will be reported. H. N. Eaton, Bureau of Standards, is secretary of the section on hydrology.

SANITARY DIVISION, San Francisco Section, American Society of Civil Engineers, held its initial meeting March 22, with an attendance of about 70. The technical program consisted of papers on garbage-disposal problems in San Francisco Bay region: "Observations on Beccari System Garbage-Disposal Plants," by Prof. Charles Gilman Hyde; "Oakland's Experience With Garbage Disposal at Sea," by Walter N. Frickstad, city engineer, Oakland; "Berkeley's Experience With Sanitary Fill," by Harry Goodridge, city engineer, Berkeley; and "Palo Alto's Experience With Incineration," by J. R. Boxhee, Jr., city engineer, Palo Alto. Harold F. Gray presided.

Obituary

WILLIAM A. STARRETT, president of Starrett Corp., of New York, died March 26. A sketch of his life will found on p. 486.

PERCY L. BARTLETT, building contract of Niagara Falls, N. Y., died on Mar 23. Mr. Bartlett was born in England years ago, but had resided in Niag Falls for 40 years.

WILLIAM H. BARRY, of St. Petersbu Fla., died on March 22. Mr. Barry w born in Cincinnati, Ohio, and was gradua from Rensselaer Polytechnic Instit class of 1871. After several years in t practice of engineering, Mr. Barry spent years in the educational field. He was t first to introduce vocational guidance in the public schools of New Jersey.

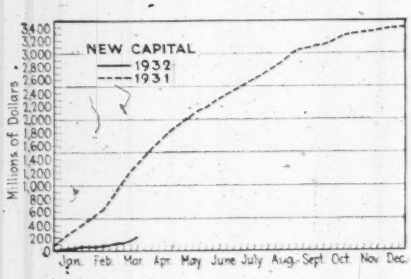
FREDERICK G. RAY, principal engine U. S. Lake Survey, died on March 21 his home in Detroit. Mr. Ray was bo 60 years ago and was graduated from t University of Iowa with a degree of bach lor of science in civil engineering in 189 After his graduation he became connect with the Mississippi River Commission a in 1901 was transferred to the Survey.

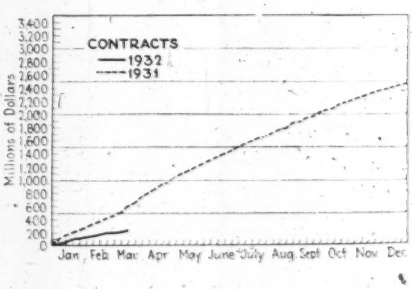
MARCUS RAMSEY, of Mohawk, N. Y died on March 23, at the age of 69. Mr Ramsey was born in Wisconsin and wa graduated in 1885 from Rensselaer Poly technic Institute with a degree in civil en gineering. After his graduation he wa engaged in railroad building in Florida and later was with the U. S. government in the St. Johns River Commission water storage investigation in Nevada. He wa in charge of the Mohawk division on th deepening of the Erie Canal.

AGNEW T. DICE, president of the Reading Co., died suddenly on a street car on March 25 in Philadelphia. Mr. Dice, who was 70 years old, had been president of the company since 1918. He started his railroad career in 1881 with the Pennsylvania R.R. and at night studied civil engineering, making a special study of railroad signaling. In 1897 Mr. Dice went with the Philadelphia & Reading R.R. as assistant superintendent of the Reading division and was made president of that railroad in 1916 and president of the Reading Co., owner of the road, two years later.

Capital and Contracts

New capital issues of the week ended March 26 reached a total of $32,000,000, compared with $53,000,000 in the preceding week and $147,000,000 as an average week for March, 1931. Public issues accounted for $12,000,000 of the total, with $20,000,000 in private financing. Cumulatively, the total for the period Jan. 1 to March 26, inclusive, is $213,000,000, compared with $1,206,000,000 in 1931.





Construction Equipment and Materials

New Equipment in Brief

Tractors—The Cleveland Tractor Co., Cleveland, Ohio, announces a new Cletrac 25, equipped with a Hercules six-cylinder motor and electric starting and battery ignition as standard equipment.

Rust Protection—The Skybryte Co., 1919 East Nineteenth St., Cleveland, Ohio, announces the development of "Rust-Tox," a colorless and transparent fluid for the protection of metals against rusting. Rust-Tox may be used in its clear form over new or corroded metals for protection against rust, or may be pigmented with aluminum flakes or other pigments to form a paint. It is claimed that the material when used as a shop coat kills rust and has the advantage of baking on instead of burning out under the heat of riveting.

Welding Electrodes—A new line of arc-welding electrodes, which has a heavy all-mineral flux coating has been placed on the market by the Metal & Thermit Corp., 120 Broadway, New York, acting as sales agent for the American Murex Corp., the manufacturer. The new electrodes, known as Murex, are made 18 in. long, and in sizes suitable for a wide range of horizontal, vertical and overhead welding operations. The feature of the electrode is a patented spiral winding of asbestos yarn which serves to hold the heavy mineral flux to the core so that it is not injured if the electrode is bent.

Gas Engine Primer—P-O-L Primer, a device for facilitating the starting of gasoline engines, either automobile or stationary, has been introduced by the Linde Air Products Co., 30 East 42d St., New York. The primer is a simple and easily installed device for introducing acetylene, a highly combustible gas, into the cylinders of an internal combustion engine so that it will start easily and quickly. The assembly is used in conjunction with the ordinary Prest-O-Lite tanks.

Clamshell Bucket—The Wellman Engineering Co., Cleveland, Ohio, now handling the Williams line of clamshell buckets, announces the new Williams type "MF" multiple rope clamshell bucket, available in sizes from ½ to 2 cu.yd. The multiple rope type is a departure from the Williams standard line of lever arm type of buckets. Low headroom, quick opening and high digging efficiency are claimed for the new bucket.

Lifting Magnet—A new 30-in. heavy-duty lifting magnet has been introduced by Cutler-Hammer, Inc., 238 North Twelfth St., Milwaukee. This new magnet is especially suitable for use with crawler type cranes and on installations where the size of the d.c. generator must be small and the lifting capacity of the magnet high. A 24-kw. generator is all that is required. The weight of the magnet is 1,300 lb.

Welding Torch—The Alexander Milburn Co., 1416 West Baltimore St., Baltimore, Md., announces a new welding torch known as type HMS. The torch, suitable for all types of welding, is furnished with copper, swaged welding tips, but these may be removed from the torch handle and replaced by extensions of various lengths.

Three New Stone and Chip Spreaders of Different Types

THREE different types of spreaders for handling stone, chips, sand and calcium chloride have recently been developed by as many manufacturers. Each has its own characteristics and different power applications, one taking power from the truck wheel, another from its own traction and the third from an independent gas engine.

G.S.C. Hi-Speed Spreader

The G.S.C. Hi-Speed spreader, manufactured by the Efficient Road Machinery Co., Inc., Syracuse, N. Y., is a unit that attaches directly to the truck body without using special adaptors or requiring the boring of holes. The spreader is powered by a take-off from one of the rear truck wheels. The width of spread can be varied from 1 to 8 ft. and the depth from a light sprinkle to a layer several inches deep. The spreader will handle any material in size up to No. 3 stone. Its operation can be controlled by the truck driver by the aid of one rope, or an additional man may be used, working from a platform at the rear of the truck. The spreader works equally well with a forward or reverse travel of the truck.

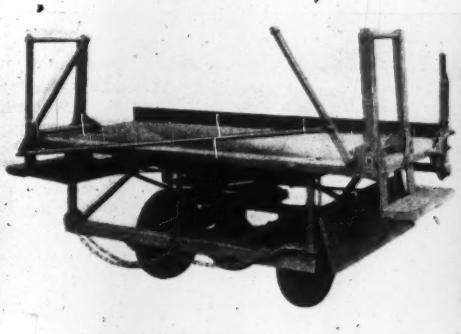
Differential Disc Spreader

The Universal Crane Co., Lorain, Ohio, announces a new material spreading device known as the Differential Disc Spreader. It is a trailer unit, mounted on two pneumatic-tired wheels. Power for operation is obtained through traction of the wheels, which drive back through a standard automotive type of four-pinion differential. Distribution is accomplished by dropping the materials onto a disk revolving in a horizontal plane. Materials are cast outward and downward by centrifugal force, permitting a spread of about 16 ft. with heavy materials and 30 ft. with light materials. The materials strike the surface at a sharp angle with heavy force, giving good penetration into the voids of the base. The width of spread is dependent upon the speed of the truck, while the thickness of material spread is regulated by varying the gate opening through which the materials pass onto the disk. The major advantage claimed for the differential type of drive in connection with the pneumatic tires is its ability to spread dust and screenings as a binder over larger stones without disturbing the interlocked stone surface. The differential action also provides even distribution on curves.

Hercules-Ditwiler Spreader

The Hercules-Ditwiler trailer-type spreader, made by the Ditwiler Mfg. Co., Galion, Ohio, is a self-powered unit handling any material up to 1 in. maximum size. It is operated by an air-cooled gas engine, and the width of spread, 6 to 30 ft., is regulated by the speed of the engine and is always uniform regardless of truck speed. The amount of aggregate spread depends upon the truck speed. The unit is especially designed for lighter dump trucks, although by means of a simple adjustment, it can be used with larger trucks. Material is spread by means of a revolving disk. Agitator blades in the feed hopper break up any lumps in the material. An additional hopper is supplied for use in spreading chloride from non-dumping trucks. The weight of the spreader—engine, hoppers and all—is 535 lb. In operation this weight is supported in part by the truck and in part by a single rubber-tired wheel at the rear.

G.S.C. Hi-Speed Spreader.



Differential Disc Spreader.

Hercules-Ditwiler Spreader.

Current Construction Unit Prices

Dam 4, Monongahela River, Charleroi, Pa.

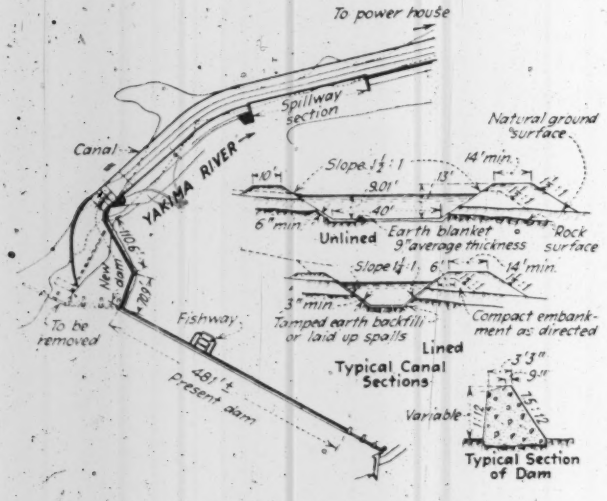
DAM 4 is being constructed in the Monongahela River near Charleroi, Pa. Contract was awarded in December, 1931, by the U. S. Engineer Office at Pittsburgh to the Dravo Contracting Co., Neville Island, for $235,581. This contractor is also building a lock at the site. Construction of the dam starts with the construction of the abutment and proceeds toward the lock in successive box-type cofferdams. Contract unit prices are given below. Major W. D. Styer is district engineer.

551 lin.ft. cofferdam per linear foot of permanent work inclosed	$80.00
26,105 cu.yd. common excavation	.50
50 cu.yd. rock excavation	4.00
6,000 cu.yd. fill	.40
14,874 cu.yd. concrete	10.00
36 cu.yd. concrete paving	20.00
665 cu.yd. derrick stone	7.00
20,574 sq.ft. sheetpiles, steel	1.40
32,296 lin.ft. round piles, timber	.64
891 lb. structural steel	.20
71,840 lb. reinforcing rods	.00
34 lb. cast iron	.30
1,081 lb. bolts	.20
138 lin.ft. pipe, 2-in. steel	1.00
137 lin.ft. pipe, 2½-in. steel	1.00

Prosser Diversion Dam, Power Plant, Power Canal, Washington State

NEW works being constructed at Prosser, Wash., by the U. S. Bureau of Reclamation on the Kennewick division of the Yakima project consist of alterations to the Prosser diversion dam, earthwork and structures for a 9,500-ft. power canal, and construction of a power house. Power machinery will be installed by the government and is not included in this contract, awarded in January for $131,387.

Government will furnish cement, aggregates, reinforcement, pipe and other materials going into the finished structures. Excavation is of three classes: (1) material that can be plowed to a depth of 6 in.; (2) all other material; (3) rock and large boulders. The compacted portion of the canal embankments are built in 6-in. layers, of material taken from the canal or from borrowpits. Unlined portions of the canal that are in porous material are blanketed with 9 in. of top soil.



General plan and typical sections, Prosser diversion project.

Standard concrete mix is 1:2.8:4.2. Largest volume of concrete is in the canal lining, minimum thickness 3 in. Concrete structures include the dam and spillway retaining walls, power plant and penstock. The new dam is 180 ft. long, averages 10 ft. high, and is 10 ft. wide at bottom and 3½ ft. at top. Power house is 48x33 ft. in plan by 35 ft. high.

Sixteen bids were received and unit prices are given for the lowest three: (A) General Construction Co., 3840 Iowa Ave., Seattle, contract, $131,387; (B) Addison Miller, Inc., St. Paul, $139,978; (C) J. A. Torteling & Sons, Spokane, $142,783.

Excavation	A	B	C
72,000 cu.yd. class 1	$0.10	$0.14	$0.14
18,700 cu.yd. class 2	.25	.36	.30
66,000 cu.yd. class 3	.35	.70	.60
60,500 cu.yd. overhaul	.03	.025	.05
37,500 cu.yd. compact. embank.	.25	.25	.25
7,300 sq.yd. preparing foundation for conc. lining in rock excav.	.55	.23	.40
10,200 sq.yd. trimming canal in earth for conc. lining	.20	.15	.15
23,600 sq.yd. earth blanket	.06	.12	.10
3,900 cu.yd. backfill	.25	.40	.20
Concrete			
400 cu.yd. in diversion dam and walls	7.50	6.50	8.00
1,120 cu.yd. in structures	12.00	10.50	16.00
1,640 cu.yd. in canal lining	9.00	4.40	10.00
525 cu.yd. in power plant	7.50	8.50	14.00
Placing 210,000 lb. reinf. bars	.01½	.014	.02
Installing 49,300 lb. gates and operating mech.	.03	.04	.02

Cutoff Levee in Indian Grave Drainage District, Ill.

A NEW CUTOFF levee 0.75 mile long averaging 16 ft. in height and containing 165,000 cu.yd. of material is being constructed along the Mississippi River 350 miles above Cairo, Ill., in the Indian Grave Drainage District. Contract was awarded in January, 1932, by the U. S. Engineer Office at Rock Island for $18,018. Complete bids are given below. Lieut. Col. Glenn E. Edgerton is district engineer.

W. S. Hardwick, Beardstown, Ill.	$0.1092	$18,018
L. E. Sternberg, Creston, Ia.	.1144	18,876
Frank Shannon, Savanna, Ill.	.1180	19,470
W. H. Darragh Co., Milwaukee, Wis.	.125	20,625
Matthews Bros. Constr. Co., Erie, Ill.	.1344	22,176
M. W. O'Meara, Quincy, Ill.	.1372	22,638
C. E. Walker, Cedar Rapid, Ia.	.15	24,750
Missouri Eng. & Contg. Co., St. Louis	.1645	27,143
Yale & Reagan Co. and Benson-Kaiser Co., St. Louis	.17	28,050
Cameron, Joyce & Co., Keokuk, Ia.	.175	28,875

Dredging Rock and Earth in Illinois Waterway

CHANNEL 23 miles long, 10 ft. deep and 200 to 300 ft. bottom width will be dredged in earth and rock in the Marseilles Pool of the Illinois waterway. Bids were received March 15, 1932, by the U. S. Engineer Office, Chicago, and contract was awarded on the low bid of $886,500 for the job. An item of note is that there was on the job and in good shape considerable equipment belonging to the state of Illinois that could be purchased or leased by the successful contractor. This equipment included a dipper dredge, a towboat and nine barges. Bid prices were as follows:

	1,954,000 Cu.Yd. Common Excav.	223,000 Cu.Yd. Rock Excav.	Total Bid
R. C. Huffman Constr. Co., Cleveland	$0.23	$1.96	$886,500
Arundel Corp., Baltimore	.479	.479	1,042,783
Union Construc. Co., Chicago	.48	.48	1,044,960
Congress Constr. Co., Des Moines	.30	2.50	1,143,700
Standard Dredging Co., New York	.39½	1.80	1,178,115
Al. Johnson Constr. Co., Minneapolis	.47	2.35	1,442,430